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ART. I.—*On the Optical Phenomena presented by the "Silver-Spring," in Marion County, Florida;* by JOHN LECONTE, M.D., Prof. of Natural Philosophy in the South Carolina College.*

THE extraordinary reports in relation to the optical phenomena said to be exhibited by the "Silver Spring," induced me, under the invitation and guidance of my hospitable friend, Col. A. G. Summer of Florida, to visit it during the month of December, 1859. And although, as might have been anticipated, many reputed facts vanished under the scrutiny of careful observation, and all its so-called mysterious and wonderful phenomena are obviously referable to well-known physical principles; yet it may be interesting to give a brief statement of them, and to indicate how they may be referred to the recognized laws of physics.

This remarkable "Spring" is situated near the centre of Marion county, in the State of Florida, in latitude (about) 29° 15′ North, and longitude 82° 20′ West. It is about five miles northeast of Ocala, the county seat, and nearly in the axis of the Peninsula, being equally distant from the Atlantic and Gulf coasts. Its waters are discharged by a short stream bearing the same name (viz: "Silver-Spring") which, running about six miles, unites with the Ochlawaha (or Ocklawaha) a tributary of the St. Johns river. The stream takes its origin in a deep pool or head-basin, which is called, *par excellence*, the "Silver Spring." This

* Having been read before the "American Association for the Advancement of Science," at the Newport Meeting, August, 1860.

basin is nearly circular in shape, about 200 feet in diameter, and is surrounded by hills covered with live-oaks, magnolias, bays, and other gigantic evergreens. The amount of water discharged is so large, that small steamers and barges readily navigate the "Silver Spring" up to the pool or head-spring, where there is a landing for the shipment of cotton, sugar, and other produce. These steamers and barges make regular trips between the Silver Spring and Palatka on the St. Johns. The boatmen informed me that at its junction with the Ochlawaha, more than one half of the water is contributed by the Silver Spring stream. By means of a canoe, I explored the stream for about two miles from its head; its breadth varied from 45 to 100 feet, and its depth, in the shallowest parts, from 10 to 15 feet: the smallest depth measured was not less than 10 feet in the channel of the stream. The average velocity of the stream was rudely estimated at about two miles per hour: at the narrowest portions it was estimated at three miles per hour. According to the reports of the residents, the level of the water of the Spring at the landing is subject to comparatively slight fluctuations, scarcely ever exceeding two feet. These fluctuations of level seem to be connected with the season of rains. The commencement of the rainy season varies from the 15th of June to the 15th of July. The waters of the spring begin to rise about the middle of the season of summer rains, and attain their maximum height about its termination. The maximum depth of water in the pool or basin constituting the head of the silver spring, was found to be not more than 36 feet in the deepest crevice from which the water boils up: the general depth in the central and deep parts of the basin was found to be about 30 feet. These measurements were made by means of a heavy plumb-bob attached to a twine, to which bits of white cloth were secured at intervals of six feet, or one fathom. As the plumb-bob as well as each piece of white cloth indicating the fathoms, could be distinctly seen down to the very bottom, the measurements were of the most satisfactory character. Inasmuch as accurate quantitative determinations, however easily applied, are seldom resorted to by the unscientific, we need not be surprised, that the real depth of this spring falls very far short of its reputed depth. In South Carolina, the reported depth was variously stated at from 120 to 150 feet: on the confines of Florida it was reduced to 80 feet: while the smallest estimate in the vicinity of the spring was 45 feet! This affords an illustration of the general law, that the accuracy of popular statements bears an inverse proportion to the distance from the point of observation: probably, like all emanations from centres, following the law of inverse squares.

Doubtless, the greater portion of the water which flows in the Silver-Spring river is furnished by this principal or head-spring;

but there are several tributary springs of similar character along the course of the stream, which contribute more less to the volume of water. These usually occur in deep basins, or coves (as they are called), in recesses along the margin of the stream. The depth of one of these coves situated about 200 yards below the head-spring, was found to be 32 feet in the crevice in the limestone bottom from which the water boiled: in other deep parts of the basin, the depth was about 24 feet. The "Boneyard," (so called from the fact that several specimens of the bones of the Mastodon have been taken from it,) situated two miles below the head-spring, is a cove or basin of a similar character. Its maximum depth was found to be 26 feet.

The most remarkable and interesting phenomenon presented by this spring, is the truly extraordinary transparency of the water; in this respect surpassing anything which can be imagined. All of the intrinsic beauties which invest it, as well as the wonderful optical properties which popular reports have ascribed to its waters, are directly or indirectly referable to their almost perfect diaphaniety. On a clear and calm day, after the sun has attained sufficient altitude, the view from the side of a small boat floating on the surface of the water near the centre of the head-spring, is beautiful beyond description, and well calculated to produce a powerful impression upon the imagination. Every feature and configuration of the bottom of this gigantic basin is as distinctly visible as if the water was removed, and the atmosphere substituted in its place!

A large portion of the bottom of this pool is covered with a luxuriant growth of species of water-grass, and gigantic moss-like plants (fresh-water Algæ), which attain a height of 3 or 4 feet. The latter are found in the deepest parts of the basin. Without doubt, the development of so vigorous a vegetation at such depths, is owing to the large amount of solar light which penetrates these waters. Some parts are devoid of vegetation: these are composed of limestone rock and sand, and present a white appearance. The water boils up from fissures in the limestones; these crevices being filled with sand and comminuted limestone, indicate the ascending currents of water by the local milk-like appearance produced by the agitation of their contents. At these points my plumb-bob was observed to bury itself in the mass of boiling sand.

My observations were made about noon, on the 17th and again on the 20th of December, 1859. The sunlight illuminated the sides and bottom of this remarkable pool as brilliantly as if nothing obstructed the light. The shadows of our little boat, of our over hanging heads and hats, of projecting crags and logs, of the surrounding forest, and of the vegetation at the bottom, were distinctly and sharply defined; while the constant waving

of the slender and delicate moss-like algæ, by means of the currents created by the boiling up of the water, and the swimming of numerous fish above this miniature subaqueous forest, imparted a living reality to the scene which can never be forgotten. And if we add to this picture, already sufficiently striking, that objects beneath the surface of the water, when viewed obliquely, were fringed with the prismatic hues, we shall cease to be surprised at the mysterious phenomena with which vivid imaginations have invested this enchanting spring, as well as at the inaccuracies which have been perpetuated in relation to the wonderful properties of its waters. On a bright day, the beholder seems to be looking down from some lofty airy point on a truly fairy scene in the immense basin beneath him, a scene whose beauty and magical effect is vastly enhanced by the chromatic tints with which it is invested.

Popular opinion has ascribed to these waters remarkable magnifying power. In confirmation of this, it is commonly reported that the "New York Herald" can be read at the bottom of the deepest parts of the pool. It is almost needless to state, that the waters do not possess this magnifying power, that it is only the large capitals, constituting the heading of this paper, which can be read at the bottom, and that the extraordinary transparency of the water is abundantly sufficient to account for all analogous facts. A variety of careful experiments were made with the view of testing this point, by securing printed cards to a brick which was attached to my fathoming-line, and observing at what depth the words could be read when viewed vertically. Of course, when looked at obliquely, the letters were distorted and colored by refraction. Numerous comparative experiments were likewise executed, in relation to the distances at which the same cards could be read in the air. The results of these experiments may be announced in a few words, namely:—That when the letters are of considerable size, say a quarter of an inch or more in length, on a clear and calm day, they could be read at about as great a vertical distance beneath the surface of the water as they could be in the atmosphere! Subsequently, my young friend, Dr. Henry M. Holmes, of "Silver Spring," at my suggestion, repeated several of these experiments, with identical results. In some instances, the cards were read by those who were ignorant of the words on them. The experiments were made on various sized letters, and at depths varying from 6 to 30 feet. The comparative experiments in reading the cards in air and water, serve to convey a more distinct idea of the wonderful diaphanous properties of the latter, than any verbal description.*

* Bouguer, in his *Traité d'Optique sur la graduation de la lumière*, (Paris, 1760,) gives the results of experiments made on sea water with his photometer, by which the loss of light in a column of $3^{m}{\cdot}11$ (=10·214 feet) of sea water confined in a

Some persons have thought that there was something mysteterious in the fact, that objects beneath the surface of the water, when viewed obliquely, are fringed with prismatic hues. It is unnecessary to remind the physicist, that such a phenomenon is a direct physical consequence of the laws of dispersion of light by refraction. Observation proved that white objects on a dark ground were fringed with blue at the top and orange and red at the bottom; while the color of the fringing was reversed for dark objects on a white ground. This is exactly in accordance with recognized optical principles.* In the present case, the phenomenon is remarkably striking and conspicuous, probably, from two causes: *First*, because the extraordinary transparency of the water rendered subaqueous objects highly luminous; and *Secondly*, because the gigantic evergreens which fringed the pool cut off most of the surface reflection, which would otherwise have impaired the visual impression produced by the more feeble refracted and dispersed light proceeding from the objects. The shadow of the surrounding forest formed a dark background, analogous to the black cloud on which a rainbow is projected.

One of the optical phenomena presented by this spring, at first sight, seemed somewhat paradoxical:—namely, that when looking vertically, the depth of the pool appeared to be exaggerated. This fact was most strikingly and satisfactorily illustrated by the exaggeration of the apparent intervals between the bits of white cloth indicating the fathoms on my sounding-cord. The fathoms near the surface underwent a somewhat greater apparent elongation than those nearer the bottom, but all were exaggerated in length. This phenomenon was observed in all places and under all circumstances, was the same whether viewed with one or both eyes; and presented the same appearance to all observers. The apparent length of the upper fathom was variously estimated at from 8 to 10 feet.

In ordinary cases of considerable obliquity of view, it is a familiar fact, that the water appears to be shallower than it really is, in consequence of the seeming elevation of the bottom produced by refraction. Hence the foregoing facts in relation to the apparent exaggeration of depth, may seem to be inconsistent

prismatic box with plates of polished glass at the ends was in the ratio of 3 : 1 compared with the standard candle in air. As we had occasion to mention in vol. xxx, p. 243, this observer estimated that in sea water, at the depth of 311 French feet, the light of the sun would be equal only to that of the full moon, and at the depth of 679 feet would wholly disappear. Compared with these results the observation of Dr. LeConte on the transparency of Silver Spring appear remarkable, and we hope this excellent observer will take occasion to repeat Bouguer's measurements with the water of Silver Spring, and aided by the improved means of modern research in this department of physics.—Eds.

* Vide Herschel's Treatise on Light, *Encyc. Metrop.*, Article 429.

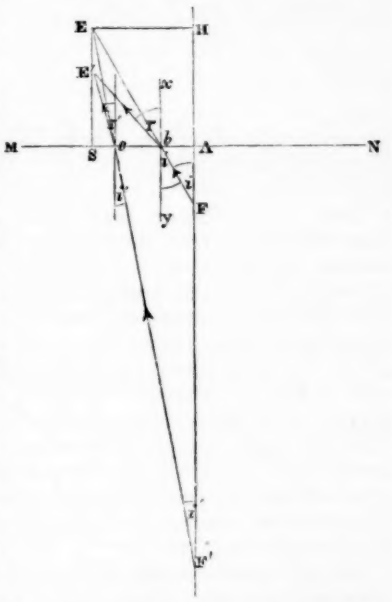
with recognized optical principles. But a little reflection will show that when the eye is placed near the surface of the pool, and when we are looking down in a direction approaching the vertical, the only method of estimating its depth is by means of the apparent intervals between intervening objects, as for example, the intervals between the branches of a sunken tree and the bottom, or between the fish and the subaqueous vegetation over which they are swimming, or between the fathom marks on the sounding-line. Now, from well known optical principles, it is obvious that the apparent distance between two objects thus viewed, depends, *caeteris paribus*, on the angle which they subtend at the eye. Thus, for instance, the apparent length of a fathom on the sounding-cord, will depend on the magnitude of the angle made by the rays of light proceeding from the upper and lower bits of cloth which mark the interval. And inasmuch as the rays of light proceeding from the fathom mark which is nearer the surface make a greater angle of incidence than those coming from the mark next below, they must undergo a greater degree of refraction, hence the apparent angle subtended at the eye by the interval in question (one fathom,) is greater than if it had been viewed in the air, and therefore the length seems to be exaggerated.

Moreover, as the apparent length of a fathom depends on the angle subtended at the eye, while the degree of refraction is proportional to the sine of the angle of incidence; it follows that when the incidence is large, the augmentation of the angle by refraction will be relatively greater than when it is small. Hence the uppermost fathom should appear to be longer than those below it; this is precisely in conformity with observation. Our estimate of the decrease of these apparent lengths with increasing depth, is doubtless vastly exaggerated by the greater fore-shortening of the lower fathoms. But as all of them seem to be more or less elongated, and as the whole depth is thus —as it were—measured by exaggerated linear units, it must appear to be greater than the reality.

The general result to which these optical laws lead is, that to an observer sitting in a boat in the middle of the pool, the bottom near the margin (if visible at all, for if the angle of incidence is too large, the light from subaqueous objects will be totally reflected, and will not emerge from the water,) will seem to be elevated and the water appear to be shallower than it really is; while the bottom near the centre will seem to be depressed, and the apparent depth exaggerated. In other words, near the margin, the depth is measured by the angle made at the eye by the rays proceeding from submerged objects with those coming from the shore-line; this angle being diminished by the refraction of the former, the depth is apparently diminished. On the

other hand, when looking directly downwards, we measure the depth by the angle made at the eye by rays emanating from upper and lower submerged objects, this angle being augmented by the greater refraction of the former, the depth is exaggerated. These physical principles thus afford a satisfactory explanation of the peculiar inverted bell-shaped appearance, which the basin presents to an observer floating near its centre. They likewise explain a fact which strikes the most casual observer: namely, that when the boat is advanced toward an apparently shallow spot situated at some distance, it appears to grow deeper as we approach the point in question.

The foregoing is a general physical explanation of the phenomenon of exaggeration of depth; but the principles of optics furnish us with the means of submitting it to a numerical test, and consequently, of showing its adequacy to account for all the facts observed. Following out the graphic method, the validity of the physical explanation was at first tested by construction. While this illustrated in a very satisfactory manner, the accuracy of the deductions which had been drawn, and their entire adequacy to explain all the observed phenomena, at the same time it enabled me to throw the question into a more severe mathematical form. Assuming the surface of the water to be a horizontal plane, and the sounding-line to be vertical, the application of a few elementary principles of geometry and trigonometry will enable us to submit the question to this more rigorous test. In the annexed figure, let M, A, N, be the surface of the water, H, A, F, F′, F″, etc., the sounding-line, E, the position of the eye receiving light from the successive fathom marks, F, F′, F″, etc., assuming no water to be interposed, and E′ the position of the eye receiving the corresponding rays after refraction by the water.



Let E S=H A $=h$, (the height of E above the water).
" A F $=d$, (the depth of first fathom mark).
" F F′, F′ F″, etc., =L, (the length of the fathoms).
" i, i', i'', etc., =the angles of incidence.
" r, r', r'', etc., =the corresponding angles of refraction.
" n =the index of refraction for water=1·336.

From the law of refraction, $\sin r = n \times \sin i$, and $\sin r' = n \times \sin i'$, etc. By geometry, the angle subtended at E by F F′ $= i - i'$: also the angle at E′ after refraction $= r - r'$. Then by trigonometry we have $\cot i' = \frac{h+d+L}{(h+d)\times \tan i}$; $\cot i'' = \frac{h+d+2L}{(h+d)\times \tan i}$, etc. Hence it follows, that when h, d, L, and i are given, i' i'' i''', etc., may be calculated, and consequently, r, r', r'', r''', etc., may be found: hence the angle subtended at E by F F′ $(=i-i')$ as well as that subtended at E′ $(=r-r')$ by the same fathom-interval, become known. For the sake of illustrating this point, let us assume $h=2$ feet; $d=1$ foot; L=6 feet; and $i=30°$. Then, by the application of the formula above given, and the geometrical and physical principles already indicated, the following table has been calculated for the foregoing condition of things:

			Angle subtended at E.		Angle subtended at E′.	Ratio of E to E′.
i =30°	r =41° 54′ 46″	By F F′	=19° 6′ 24″	By F F′	=27° 17′ 18″	6 : 8·57
i' =10° 53′ 36″	r' =14° 37′ 28″	" F′ F″	= 4° 18′ 24″	" F′ F″	= 5° 48′ 34″	6 : 8·09
i'' = 6° 35′ 12″	r'' = 8° 48′ 54″	" F″ F‴	= 1° 52′ 18″	" F″ F‴	= 2° 30′ 37″	6 : 8·05
i''' = 4° 42′ 54″	r''' = 6° 18′ 17″	" F‴ F⁗	= 1° 2′ 41″	" F‴ F⁗	= 1° 23′ 56″	6 : 8·03

From this it follows, that, under the assumed conditions, the first fathom-interval is exaggerated in the ratio of 6 to 8·57, whilst the others are elongated in a ratio but slightly greater than 6 to 8. If the angle i (other conditions being the same) had been taken larger, the excess of elongation of the first fathom-interval would have been greater. It thus appears, that all of the fathom-intervals are exaggerated nearly in the ratio of 6 to 8 or 3 to 4:—that is, sensibly in the ratio of the sines of the angles of incidence and refraction for water. This is only true for small angles of incidence, that is, for the lower fathoms; for, in that case, the sines may be considered proportional to the angles. Hence, the real depth of this pool being 36 feet; the apparent depth, assumed to be measured by the exaggerated linear units would be 48 feet.

Strictly speaking, the rays of light emanating from the successive fathom marks, which, under the assumption of no refraction, reach a given point E, would not all after refraction, arrive at the same given point E′: so that, in strictness, the rays of light which enter the eye at E′ are, for the lower fathoms, those which emerge from the water under very slightly different angles of incidence from those given in the table. But it is ob-

vious, that its influence on the deduced ratio of the angles subtended at E and E', would be wholly inappreciable.

The rigorous solution of this problem in physical optics, involves the application of that refined physico-mathematical reasoning, which has not ceased to exercise the ingenuity of some of the greatest geometers, since the period (in 1682), when Tschirnhausen first called attention to *Caustic Curves*. Sir John Herschel shows, that when the refracting surface is plane, and the refraction is made from a denser into a rarer medium, as from water into air, "the *Diacaustic* curve is the evolute of an ellipse, whose major axis is normal to the plane refracting surface; the radiant point being in the lower focus, while the centre of the ellipse is at the intersection of the major axis with the refracting surface."* In this case, the radiant is a fixed point, and the eye is supposed to view it under all possible angles of emergence. The case which we have under consideration is not materially different. Here the eye is fixed and the radiant consists of a series of equi-distant points descending vertically. In fact, Messrs. Engel and Schellbach, in their admirable *Darstellendende Optik*, have presented us with beautiful graphic representations of the exaggeration and distortion which submerged objects undergo when viewed by the eye placed in various positions above the plane refracting medium.†

Thus, it has been shown, that all of the beautiful optical phenomena presented by the Silver-Spring are referable to recognized physical principles, and that all of the so-called mysteries of its waters vanish under the scrutiny of exact science. It only remains to indicate the causes which produce the extraordinary transparency of the water, upon which, as has been shown, the entire group of phenomena is dependent. It may be remarked, that these diaphanous properties are perennial: they are not in the slightest degree impaired by season, by rain or drought. The comparatively slight fluctuations in the level of the water in the pool, to which allusion has been made, produced by the rainy season, are not, (according to the uniform testimony of the residents), accompanied by any turbidity of its waters. At first sight, it may seem paradoxical that, in a country where semi-tropical summer rains occur, the waters of this stream should not be rendered turbid by the surface drainage. But the whole mystery vanishes, when we consider the peculiar character of the drainage of this section of Florida. Although the surface of the

* *Vide*, Herschel's Treatise on Light. *Encyc. Metrop.* Article 238, Fig. 39.

† *Vide*, Darstellendende Optik, von F. Engel und K. Schellbach. *Halle*, 1856. Taf. 1, Fig. 3 et 4. Under such conditions, submerged objects not only appear to be exaggerated in length, but they seem to be more or less *curved* in the common plane of incidence and refraction, the centre of concavity being towards the observer.

country is quite undulating or rolling,—the summits of many of the hills being 30 or 40 feet above the adjacent depressions,—yet, there is no surface drainage: there is not a brook, rivulet, branch, or swamp to be found in this part of the State. The whole drainage is subterranean: even the water which falls near the banks of the Silver-Spring passes off by under-ground channels. There is not the slightest doubt, but that all of the rain-water which falls on a large hydrographic basin passes down by subterranean channels, and boils up and finds an outlet to the St. Johns river, by means of the Silver-Spring and the smaller tributary springs which occur in the coves along the margin of the stream. The whole surface of the country in the vicinity of Ocala,—and probably over the area of a circle of 15 miles radius whose centre is the Silver-Spring, is thickly dotted with lime-sinks; which are the points at which the surface water finds entrance to the subterranean passages. New sinks are constantly occurring at the present time. The beautiful miniature lakes,—whose crystal waters are so much admired,—which occur in this portion of Florida, are, doubtless, nothing more than extensive lime-sinks of more ancient date.

Under this aspect of the subject, it is obvious, that all the water which falls on this hydrographic basin boils up in the Silver-Spring, after having been strained, filtered and decolorized in its passage through beds of sand and tortuous under-ground channels. It thus comes out not only entirely free from all mechanically suspended materials, but completely destitute of every trace of organic coloring matter. According to the bargemen there is a striking contrast between the color and transparency of the waters of the Silver-Spring and Ochlawaha at their junction. The latter river drains a country whose drainage is not entirely subterranean. In addition to the above-mentioned conditions, which persistently secure the waters of this Spring from the admixture of insoluble materials as well as from the discoloration of organic matters, it seems highly probable, that the minute quantity of lime which they hold in solution may exercise some influence in augmenting their transparency; for they appear to be more diaphanous than absolutely pure water. There is nothing *a priori* improbable in the idea, that the optical, as well as the other physical properties of the liquid, are altered by the materials held in solution. This is an interesting physico-chemical question which demands experimental investigation. It is proper to add that the waters of the Silver-Spring are not charged with more than the ordinary amount of carbonic acid, they deposit no carbonate of lime; so that, the amount of lime held in solution must be comparatively small.

Doubtless there are many other springs to be found in the State of Florida, whose waters possess the same optical properties as those of the Silver-Spring; although perhaps, their transparency may be less perfect. The "Suwanee Spring" is said to exhibit analogous phenomena; and the famous fountain situated ten miles from Tallahassee, called Wachulla or Wakulla, is represented as "an immense limestone basin, as yet unfathomed in the centre, with waters as transparent as crystal." Inasmuch as I have not examined these springs, I am unable to say how far the optical phenomena which they present, may be identical with those exhibited by that which is the subject of this paper.

As in some measure related to the peculiar system of subterranean drainage above indicated, it may not be deemed inappropriate to conclude this communication, with a few general remarks, in relation to the physical causes which have produced the several qualities of surface soil, which are found in the neighborhood of Ocala and the Silver-Spring. The whole of this portion of the Peninsula appears to have been originally composed of a mixture of sand and shell-limestone; probably of the Eocene period. The lime-rock comes to the surface, almost everywhere; in some cases, it is composed of nearly pure carbonate of lime; in others, silicification, to a greater or less extent, has taken place by the displacement of the lime by silex. But in all cases where its structure can be made out, it consists of a mass of conglomerated shells. The three grades of fertility at present existing in the soil of this portion of the State, appear to be owing to the greater or less facility with which the lime has been removed from it by aqueous agencies. In the fertile, and densely-wooded Hammock lands, large quantities of soft carbonate of lime may be found at or near the surface. In the Mulatto pine lands, which are extensively cultivated in cotton and Indian corn, the amount of surface carbonate is less abundant; a considerable portion of it having been either silicified or removed from the soil. While in the sterile sandy pine-lands, no lime is to be found: the whole of the rock having disappeared, excepting that which has undergone silicification. In the Hammocks, an impervious substratum of clay has prevented the lime from being carried off by the percolation of meteoric waters;—in the Mulatto lands (so-called because there is a subsoil of yellow clay) the substratum is less impervious, so that, a large portion of the lime has been removed;—while in the Pine barrens, in consequence of the absence of a clay subsoil, the whole of the surface lime has been carried off by subterranean drainage; leaving no surface rocks excepting those which are silicified. According to this view, the light pine lands, which now produce

cotton with so little labor, are in the transition stage to the pine barrens, and cannot be expected to retain their fertility for any great length of time, unless lime is restored to them by the cultivator. The heavily-timbered Hammocks require a greater outlay to bring them under cultivation; but they constitute the most valuable and enduring lands in this section of the State. Unfortunately they embrace but a comparatively limited area, when contrasted with the space occupied by the pine lands. The outlines of the Hammocks, as indicated by the dense growth of gigantic evergreens, is singularly and sharply defined, either dotting or intersecting the desolate pine-barrens; sometimes forming narrow sinuous verdant bands extending ten or fifteen miles, which, at a distance, remind one of extensive swamps, or the bottom lands bordering a stream.

Columbia, S. C., June, 1860.

ART. II.—*On Nobert's Test Plate and the Striæ of Diatoms;* by W. S. SULLIVANT and T. G. WORMLEY.

THE limit of the resolvability of lines, or how small a space can exist between lines and still admit of their being separated under the microscope, appears to be an undecided point. Prof. Queckett (Treatise on the Microscope, 3d ed., p. 238, 1855) asserts that "no achromatic has yet been made capable of separating lines closer together than the $\frac{1}{33,000}$ of an inch." In the same work, p. 245, it is stated that Mr. Ross found it impossible to ascertain the position of a line nearer than the $\frac{1}{20,000}$ of an inch. We find also on p. 512 that Mr. De La Rue, in his extended examination of Nobert's Test Plates, was unable to resolve any lines closer than the $\frac{1}{17,000}$ of an inch. In Prof. Carpenter's work (The Microscope, 2d ed., p. 189, 1859) this sentence occurs: "the well defined lines on Nobert's Test Plates have not yet been resolved when they have approximated more closely than the $\frac{1}{23,000}$ of an inch."

From the foregoing it appears that actual experiment fixes the limit of resolvability at about $\frac{1}{17,000}$ of an inch: this does not, as is said, vary widely from the deductions of Fraunhofer and others, based on the physical properties of light. In this connection the remark (op. cit. p. 47) of Prof. Carpenter may be cited, "there is good reason to believe that the limit of perfection (in the objective) has now been nearly reached, since everything which seems theoretically possible has been actually accomplished."

On the other hand there are authorities who assert that lines much closer than the $\frac{1}{33,000}$ of an inch are resolvable. A few

years since Messrs. Harrison and Sollitt published (Microscopical Journal, vol. ii, p. 61, 1854) their measurements of the striæ of several diatoms, assigning to Amphipleura pellucida striæ as close as the $\frac{1}{125,000}$ to $\frac{1}{130,000}$ of an inch. These measurements have recently been repeated, and with exactly the same results, by Mr. Sollitt alone (Mic. Jour., viii, p. 51, 1859) who furthermore expresses the opinion that striæ as close as the $\frac{1}{175,000}$ of an inch can, with proper means, be seen. Mr. Sollitt's measurements have been adopted in the Micrographic Dictionary (1860) and most of the modern works on the Microscope, no one, Prof. Carpenter (op. cit., p. 188) excepted, suggesting a doubt as to their accuracy; on the contrary, their correctness seems to be expressly recognized by Dr. G. C. Wallich (Ann. & Mag. Nat. Hist. for February, 1860).

Such being the conflicting testimony and opinion of distinguished microscopists on the capacity of the modern objective for separating lines, it is somewhat surprising—in veiw of the high state of perfection now attained by the microscope, and of the number of its zealous devotees—that so few experiments have been made, bearing on this interesting point.

As a contribution toward that object, we propose to offer presently an analysis from actual measurements, as far as we were able to carry them, of one of those "marvels of Art," Nobert's Test Plates. In such investigations the quality of the instruments used being all important, we would state that the optical apparatus at our command was ample, consisting of a first class Smith and Beck microscope stand, a Tolles' $\frac{1}{30}$ objective of 160° angular aperture—an objective of rare excellence in all respects—besides $\frac{1}{12}$ths and $\frac{1}{16}$ths of other eminent opticians, both English and American; also a solid eye-piece micrometer by Tolles, and an improved cobweb micrometer of Grunow's accurate workmanship. Smith and Beck's stage scales furnished the standards for fixing the micrometrical values of the eye-pieces. By means of Tolles' amplifier, an achromatic concavo-convex lens between the objective and the eye-piece, an amplification (by the standard of 10 inches) as high as 6000 times was obtained. This high amplification, with sunlight variously applied after passing through a small achromatic lens of long focus, was effective in resolution, and essential to the distinct counting under the micrometer of the lines of the test plate. The test plate used consisted of 30 bands of lines, each band varying but little from the $\frac{1}{25,000}$ of an inch in width, and having its lines a uniform distance apart. On one end of the plate is engraved by Nobert, in parts of the Paris line, the distance apart of the lines composing the first band, and thence on, the distance between the lines of every fifth band, as in the 2d and 5th columns of the following table.

Band.	Par. line.	Eng. in.	Band.	Par. line.	Eng. in.
1	0·001000	$\frac{1}{11,248}$	20	0·000167	$\frac{1}{67,413}$
5	0·000550	$\frac{1}{20,471}$	25	0·000143	$\frac{1}{78,737}$
10	0·000275	$\frac{1}{40,943}$	30	0·000125	$\frac{1}{90,074}$
15	0·000200	$\frac{1}{56,297}$			

We add the 3d and 6th columns, giving the distances in parts of the English inch found by multiplying the decimals in the 2d and 5th columns by ·088815.

Analysis of Nobert's Test Plate of 30 Bands.

Bands.	Lines in each band.	Parts of an English inch.	Bands.	Lines in each band.	Parts of an English inch.
1	7	$\frac{1}{11,110}$	16	30	$\frac{1}{57,518}$
2	8	$\frac{1}{13,062}$	17	31	$\frac{1}{58,623}$
3	9	$\frac{1}{15,372}$	18	32	$\frac{1}{62,155}$
4	10	$\frac{1}{17,950}$	19	33	$\frac{1}{63,322}$
5	12	$\frac{1}{20,224}$	20	34	$\frac{1}{66,947}$
6	13	$\frac{1}{23,287}$	21	36	$\frac{1}{68,047}$
7	15	$\frac{1}{27,705}$	22	37	$\frac{1}{71,960}$
8	17	$\frac{1}{32,250}$	23	38	$\frac{1}{73,190}$
9	20	$\frac{1}{37,792}$	24	40	$\frac{1}{74,256}$
10	22	$\frac{1}{40,636}$	25	41	$\frac{1}{76,200}$
11	24	$\frac{1}{45,063}$	26	42	$\frac{1}{78,105}$
12	25	$\frac{1}{47,331}$	27	43	$\frac{1}{81,213}$
13	26	$\frac{1}{50,000}$	28	44?	$\frac{1}{83,317}$
14	28	$\frac{1}{52,610}$	29		$\frac{1}{86,334}$
15	29	$\frac{1}{55,000}$	30		

The figures in the 3d and 6th columns, showing the distance apart of the lines in each band, are the mean of numerous and slightly variant trials, particularly on the higher bands. Up to the 26th band there was no serious difficulty in resolving and ascertaining the position of the lines, but on this and the subsequent ones, spectral lines,* that is, lines each composed of two or more real lines, more or less prevailed, showing that the resolving power of the objective was approaching its limit. By a suitable arrangement, however, of the illumination, these spurious lines were separated into the ultimate ones on the whole of the 26th,

* The tendency of lines near the limit, either way, of the objective's resolving power, to run into each other and produce spectral or spurious lines, is readily shown by a low objective on the lower bands. Hence the mere exhibition of lines is not always conclusive evidence of their ultimate resolution. A practiced eye will generally distinguish the false from the true. Recourse to a higher objective often accomplishes the same; but when these fail, the micrometer only, together with a previous knowledge of the actual position of the true lines, can determine whether the lines exhibited are real or spurious. A $\frac{1}{12}$ or $\frac{1}{16}$ will show the 3 or 4 highest bands on this plate regularly and beautifully striped with lines much coarser than the true ones; the same with the $\frac{1}{30}$ on the last band.

and very nearly on the whole of the 27th band; but on the 28th, and still more on the 29th, they so prevailed, that at no one focal adjustment could more than a portion (a third or a fifth part) of the width of these bands be resolved into the true lines.

The true lines of the 30th band we were unable to see, at least with any degree of certainty, still, from indications, we have no doubt they are ruled as stated by Nobert.

It will be observed that our measurements of the lines on the 1st, 5th, 10th, 15th, 20th, bands vary somewhat from Nobert's registration on the plate as given in the first table above. Such discrepancies are to be expected, and by microscopists familiar with operations of this kind, are looked upon as unavoidable; but that on the 25th band is rather large to be accounted for in this way. We are unable to explain it, and can only say that our repeated measurements of it were very carefully made.

These experiments, together with those of others before noticed, induce us to believe that the limit of the resolvability of lines, in the present state of the objective, is well nigh established; but that this limit may be carried somewhat higher, we are not prepared to doubt, since the handsome advance lately achieved by Mr. Tolles in his $\frac{1}{30}$—combining wide aperture, fine definition, and high amplification—shows that the objective had not, as we were inclined to think, reached the stationary point.

The theoretical view of this question, that is, what may be the closest approximation of lines consistent with their separation under the microscope, we leave to those competent to the task, by whom, it is to be hoped, we may be favored with further information on this point.

With regard to the striation of Diatoms, an opinion generally prevails that the number of striæ on a given portion of a frustule, varies among individuals of the same species, within wide extremes. This opinion is probably traceable in part to one of the earlier publications on the subject, the paper of Messrs. Harrison and Sollitt before referred to, wherein (as in the more recent paper of Mr. Sollitt) measurements of several Diatoms are given showing great variableness in their striation. To these gentlemen much credit is due for their discovery of high markings, before unsuspected, on certain diatomaceous frustules; their measurements however and the alleged variableness of these markings we have not been able to verify, as will be seen by the following extract from our paper published (this Jour., March, 1859,) on this subject.

	Number of striæ in ·001″		
	H. and S.	Sm. Syn.	S. and W.
Navicula rhomboides	60 to 111	85	70
Pleurosigma fasciola	50 to 90	64	52 to 56
Pleurosigma strigosum	40 to 80	44	42
Nitzschia sigmoidea	105	85	70

Many frustules of these species, from different localities, have been measured by us and always with the same results. Pleurosigma fasciola has been specially designated by Mr. Sollitt, and also by Dr. Wallich, as very inconstant in its markings. Of this diatom we are fortunate in being supplied with abundant specimens, from various localities in England, particularly from the neighborhood of Hull. Several hundred valves, not a few under $\frac{1}{300}$ of an inch in length, were measured, and on no one were found striæ less than 52 or more than 56 in ·001″, much the larger number being 54. A similarly uniform striation has always been observed among the individuals of many other species examined by us.

To such uniformity of striation Amphipleura pellucida forms as yet no exception; this diatom is still a "res vexata" among microscopists; neither the striation nor the structure of its frustule is at all satisfactorily understood. The record of its striation is found to be thus:—in 1854 Messrs. Harrison and Sollitt's measurements made its striæ 120 to 130 in ·001″;—Prof. Carpenter (1856) first suggests the probability of some error in these measurements;—the writers of this paper declared themselves (this Jour., March, 1859) unable to "glimpse" the striæ;—Mr. Sollitt (Mic. Jour., Oct. 1859) measures them again and finds them still as low as 120 to 130 in ·001″, but gives it as the opinion of Mr. Lobb that "even those figures are too low and that they ought to be set down at 140 in ·001″;"—in the same number of the Microscopic Journal, Mr. Rylands sees "striæ, but much more distant than the 130 in ·001″ of the Hull microscopists;"—lastly Mr. Hendry states (Mic. Jour., July, 1860) that he has "come to a satisfactory conclusion, that it is a sad misrepresentation to set down the lines so high in the scale as 130 in ·001″, and that on a few shells lines may be counted at 42, and many at 60, 70 and 80 in ·001″." A perplexing record, truly!—reminding one of the celebrated Torbane Hill coal case (Mic. Jour., ii, p. 64).

It is our impression, notwithstanding these conflicting statements, that the diatom before us presented to all these gentlemen the same appearances, but their interpretation of these appearances have been widely different.

The testimony of our objectives, as we understand it, seems to indicate that this diatom has a minutely and irregularly broken up surface, which even on the *same valve*, can be made to show an apparent striation, varying from moderately coarse to extremely fine, according to the obliquity or intensity of the illumination, and to the grade, whether low or high, of the objective used, thus proving beyond question that the exhibition is illusory. In numerous trials, particularly on fine English specimens from Hull, sent us by Mr. G. Norman, we have entirely failed, with glasses too of unsurpassed excellence, to bring out,

regular, *distinct* and *unmistakable* striæ such as would be, at once, so recognized by an eye practiced on the striæ of other diatoms.

After all, it is not improbable, that true striæ yet unresolved, may exist on the valves of this species, and furthermore, that the apparent striæ of different observers may be similar to the spectral or spurious lines before noted as occurring on the bands of Nobert's Test Plate, when examined by an objective incapable of resolving them.

A summary of the foregoing may be briefly stated thus:—that our experiments lead us to believe

1st. That lines on Nobert's Test Plate, closer together than about the $\frac{1}{87000}$ of an inch, cannot be separated by the modern objective.

2d. That no *true* striæ have yet been seen on the valves of Amphipleura pellucida.

3d. That the alleged variableness in the striation of diatoms among individuals of the *same* species has been greatly exaggerated: on the contrary, we find a remarkable uniformity, thus sustaining the opinion of Prof. Smith (Synop. Br. Diat., v. 2, Introd., p. 26) that for characterizing species "striation is the best guide."

Columbus, Ohio, Nov., 1860.

Art. III.—*On the Track of an Animal lately found in the Potsdam Formation;* by Sir W. E. Logan, F.R.S.*

(Read before the Natural History Society of Montreal, June, 1860.)

The Potsdam sandstone is recognized in Canada and New York as the base of the Lower Silurian series. As far as we are certain of the formation in the province it rests unconformably upon the Laurentian series; but on the north shore of Lake Huron, the Huronian series supports unconformably a sandstone which has been supposed to be Potsdam; as no fossils, however, have been met with in it there, its equivalence is somewhat doubtful, particularly as the superior fossiliferous rock into which it passes, appears to be of the Bird's-eye and Black River group.

Mr. Barrande in a paper communicated to the Geological Society of France about a year ago, compares the Potsdam formation with the Primordial Zone, and appears disposed to unite it with the strata marked by *Paradoxides* near Boston in Massachusetts, and Placentia Bay in Newfoundland, the first locality yielding *Paradoxides Harlani* which he identifies with his *P. spinosus*, and the latter Mr. Salter's *P. Bennetii*, and probably other allied genera and species. But while no well ascertained Primordial spe-

* From the Canadian Naturalist, Aug. 1860.

cies have been met with in the Potsdam of Canada and New York, the formation appears in Canada to be rather allied to the strata above than those below it.*

In the Potsdam of Canada and New York, independent of fucoids, the number of species of which the forms have been either wholly or partially preserved is only three. Two of them are *Lingulæ*, named by Hall *L. prima*, and *L. antiqua;* and while these so far resemble one another that they might by some palæontologists be considered varieties of one species, we in Canada have a *Lingula* (*L. Belli* of Billings,) in the Chazy, which might almost be considered another variety of the same species, the peculiarity of them all being the length and sharpness of the beak. In Canada there is also found in the Potsdam, the impression of the spire of a large flat *Pleurotomaria*, which so strongly resembles the spire of *P. Laurentiana* (Billings) of the Calciferous, that they can scarcely be distinguished. In addition to these upward affinities in the only preserved form, there are beds of passage between the Potsdam and Calciferous formations, in which the strongly marked distinctive lithological characters of the two are well preserved, and at St. Timothy on the Beauharnois Canal those beds of the inter-stratification which are allied to the lower rock are occasionally marked by *Scolithus linearis* (Hall), supposed to be ancient worm-holes, by which the Potsdam is characterised in many parts.

Immediately beneath these beds of passage are the celebrated foot prints of Beauharnois, to which Professor Owen has given the name of *Protichnites*. Since these were described by Owen, nothing has been discovered to throw further light upon the forms of the animals which made these impressions; but in thinning a large specimen with some of the tracks on it, for the purpose of placing it in the museum of the Geological Survey, it was ascertained that the surface on which the traces were impressed must have been subject to the ebb and flow of a tide. The surface on which the tracks are impressed and the one immediately beneath, shew ripple-mark; the next in succession which is about an eighth of an inch below, shews wind-mark, in a number of sharp and straight parallel ridges from two to four inches long and an eighth or a quarter of an inch wide. These characterize a considerable surface, and are precisely similar to the marks so familiar to every person who has examined blown sand. The surface must thus have been alternately wet and dry, and the organic remains of the formation being marine, we have thus pretty clear evidence of a tide.

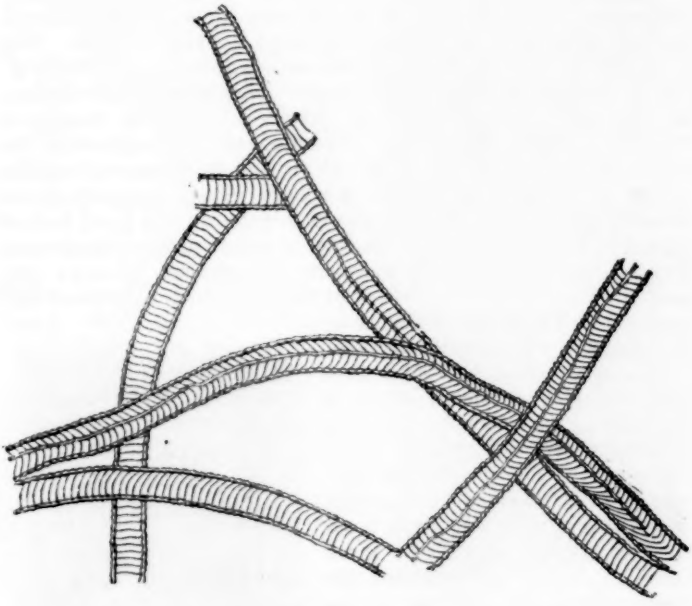
Proverbially unstable as water is, the mean level of the sea, that is the point which is half-way between high and low water,

* Since this paper was read two species of *Orthoceras* and an *Ophileta* have been discovered in Canada associated with *Lingula antiqua*, in the Potsdam Sandstone. The trilobite *Conocephalites minutus* (Bradley) has also been since described.

is supposed to be the least changeable level on the face of the globe, and taking it to be now pretty much as it was during the Lower Silurian period, we establish the means of knowing approximately how much the position where the tracks are found, is higher than it was when these were impressed, the limit of error being the number of feet which would represent the difference between the ebb and flow of the sea in the locality, or perhaps not more than fifty feet. We have thus a bench-mark to test the rise not only of these strata at Beauharnois, but of their equivalents, wherever else they may be met with.

Finding that this ancient sand bank was exposed at the ebb of tide we naturally look out for some coast to which it was related. The Potsdam sandstone terminates some twenty miles

1.



One-thirtieth natural size.

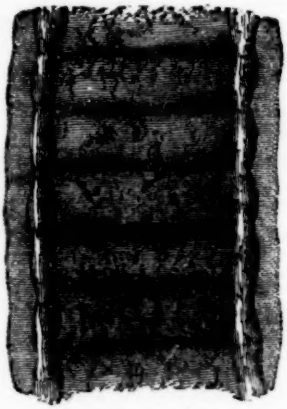
to the north at a very low angle against the foot of the Laurentide hills, which rapidly rise up 500 or 600 feet above the Silurian plain. There is little doubt that we have in the flank of those hills the ancient limit of the Lower Silurian sea, the shore of which is thus traceable from Labrador by the northwest, to the Arctic Ocean, a distance of 3,000 miles. But though we

have thus evidence of a Lower Silurian dry land and can scarcely suppose that it was wholly destitute of vegetation, we have not yet discovered any certain drifted vestige of its plants along many hundred miles of its coast.

The crustacean which impressed the tracks at Beauharnois must have been a littoral animal, tracks of which have now been found in several places nearer than Beauharnois to the marginal limit of the sea to which it belonged. These localities are St. Ann, Vaudreuil, Presqu'ile, Lachute, and St. Elizabeth, and they were last year observed in the neighborhood of Perth. In the last locality they are associated with a new and remarkable description of track, for the discovery of which we are indebted to my friend Dr. James Wilson of Perth, who sent me specimens of it in the month of November last.

The largest of the specimens was between two and three feet long by a foot wide, and the track upon it so singular that I became desirous of obtaining a greater extent of the trail. For this purpose, in the beginning of December, I sent Mr. Richardson to Perth, where he was guided to the quarry by Dr. Wilson, and shewn the bed in which the tracks occur. The quarry, of which the strata are nearly horizontal, is about a mile from the town, and with the aid of Mr. Glyn, the proprietor, Mr. Richardson obtained in fragments, a surface which measures about seventy-six square feet. To obtain this required a good deal of patience, for there was half a foot of snow on the ground, and from under this it was necessary to remove between two and three feet of rock in order to reach the bed. The rock is a fine grained white sandstone similar to that in which the *Protichnites* occurs at Beauharnois, and of that pure silicious character which is so well known to belong to the Potsdam formation wherever it is met with. The tracks are impressed on a bed which varies in thickness in different parts from one eighth of an inch to three inches. When the upper bed was removed, large portions of the track-bearing bed came away with it, and it was necessary to separate the layers. This was done by heating the surface with burning wood placed upon it, and then suddenly cooling it by the application of snow. This of course cracked and destroyed the thin bed with the impressed

2.

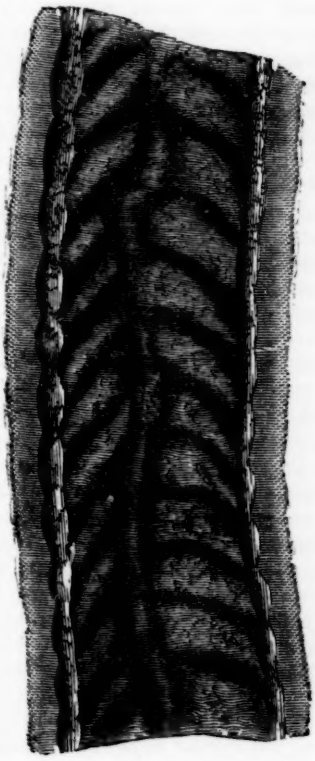


One-fifth nat. size.

tracks, but it left the mould of them on the underside of the upper bed, and by plaster casts from this we have obtained the true form of the original tracks.

These tracks consist of a number of parallel ridges and furrows something like ripple marks, which are arranged between two narrow continuous parallel ridges, giving to the whole impression a form very like that of a ladder, and as the whole form is usually gently sinuous it looks like a ladder of rope. The surface obtained shews six different trails, (fig. 1,) the longest of which is about thirteen feet, but they are all of the same breadth, and they may all have been impressed by one and the same animal. The breadth of the trails is about six inches and three-quarters to the outer sides of them.

3.



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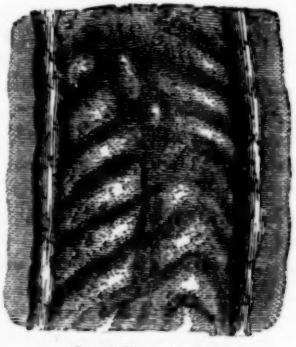
The transverse ridges and furrows are sometimes straight (fig. 2,) and sometimes curved (figs. 3, 4, 5.) When straight and regular they measure about an inch and three-quarters from the middle of one furrow to that of the next. The height of the ridge is usually from one and a half to two lines, and from the highest part of the distance to the middle of the furrows is about an inch and a quarter on one side and half an inch on the other, thus giving to the ridge a sharper slope on the shorter side. The tops of the ridges, and the bottoms of the furrows are somewhat rounded.

Though the transverse ridges are occasionally straight, (fig. 2,) they are in general either slightly or considerably curved (figs. 3, 4, 5,) and when so, the chord of the curve is seldom quite at right angles to the direction of the parallel side ridges, one end of the chord in the greatest obliquity observed being as much as two inches and a half in advance of the other (fig. 3). The height of the curve above the chord is sometimes as much as an inch and three

quarters. It is often somewhat pointed, and the highest part is not always in the middle between the parallel side ridges (fig. 4). The concave side of the curve is always on the steeper side of the tranverse ridges.

There runs along the track a ridge intermediate between the two parallel side ridges, (figs. 3, 4, 5), and though it is not so conspicuous as these, it is seldom altogether wanting, but appears to be, most obscure when the transverse ridges, or rounds of the ladder, are straight. This intermediate ridge does not keep parallel with the side ridges, but occasionally runs in sinuous sweeps from within an inch and a half of one side (fig. 5) to the same distance from the other; sometimes, however, it runs nearly parallel with the sides for a considerable distance, either in the middle or somewhat on either side of it. In one of the tracks there is in the course of the intermediate ridge a sudden dislocation of an inch and a quarter (fig. 3 towards the top,) on the opposite sides of one of the transverse ridges. The course of the intermediate ridge appears in general to coincide with the successive most salient parts of the transverse ridges when these are curved, but this is not always the case (fig. 4). The intermediate ridge appears most conspicuous where it crosses the transverse furrows, yet its crest or line of summit seems to undulate with the ridges and furrows, though not to so great a degree.

4.



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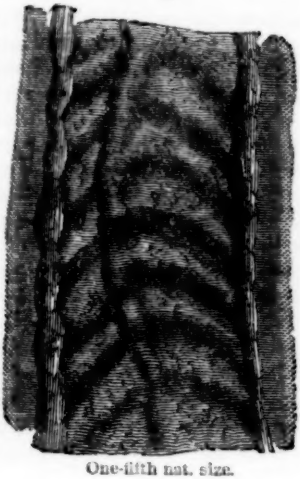
5.



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The inner flanks of the side ridges appear to be continuously even surfaces, making an angle of 155° with the plane of the intermediate spaces, and against these sloping flanks the surface of the transverse undulations form a decided, though very obtuse set of angles, just like waves rolling along an inclined plane in the direction of its strike. The side ridges

are rounded at the top, and while their exterior flanks are more precipitous than the interior ones, they swell out opposite to each transverse furrow, thus giving to the side ridges a beaded or knotted aspect, each bed of the series standing opposite a furrow. The highest part of these lumps is about three lines above the bottom of the furrows, and about a line and a half above the surface on which the track is impressed.

My naturalist friends to whom I have exhibited the specimens, appear disposed to consider the tracks those of some species of gigantic mollusc, and I am given to understand there is now living some small mollusc, whose track presents a series of transverse ridges and furrows, without, however, the longitudinal ones. From the resemblance of the track to a ladder, the name proposed for it is *Climactichnites Wilsoni*, the specific designation being given in compliment to its discoverer, Dr. Wilson.

Art. IV.—*Caricography;* by Prof. C. Dewey.

(Continued from vol. xxix, p. 348, Second Series.)

No. 265. *Carex Emoryi*, Dew.

Spicis staminiferis ternis oblongis cylindraceis terminalibus, inferioribus brevioribus sessilibus approximatis et densifloris; pistilliferis quaternis longo-cylindraceis densifloris sessilibus foliaceo-bracteatis apice staminiferis, infima omnino fertili subremota; fructibus *distigmaticis* ellipticis basi teretibus brevi-rostratis ore integris squama ovata oblonga subacuta duplo longioribus.

Culm erect, scabrous above, triquetrous, with bracts long and leafy, surpassing, and scarcely sheathing it; the upper staminate spike clubform and short-pedunculate, the other two short, contiguous and sessile; the three upper pistillate spikes staminate at the apex, the lowest wholly fertile, nearly sessile and slightly sheathed; all cylindric, erect, about 1½ to 2 inches long and densely flowered; stigmas two; fruit narrow-elliptic, tapering below, flattish, obovate and apiculate or short-rostrate, with orifice entire, and scale ovate-oblong acutish and half the length of the fruit. Whole plant glaucous or pale green.

On the Upper Rio Grande; *Bigelow.* Named in honor of Major Wm. H. Emory, United States Commissioner on the United States and Mexican Boundary Survey.

This and all the species of this paper were described in the very important Botanical Report of Prof. Torrey, LL.D., in vol. ii, part i, pp. 229–232 of the Mexican Boundary Survey, published by Congress, 1859.

No. 266. *C. Barbaræ*, Dew.

Spicis staminiferis 2 (raro 3) cylindraceis erectis terminalibusque, suprema longa pedunculata, infima subelongata; pistilliferis 3 longis 2–4 uncialibus cylindraceis, superiore erecta brevibracteata apice staminifera, inferioribus longioribus subremotis subrecurvis basi laxifloris brevi-vaginatis foliaceo-bracteatis, omnibus nigro-purpureis; fructibus *distigmaticis* oblongo-obovatis apiculatis ore integris squama oblongo-obovata dorso pallida *mucronata* brevioribus; culmo erecto glauco longo-foliato et vaginato.

Culm erect, 16–20 inches high, long-leafy towards the root and long-bracted above, glaucous; spikes 3–6, cylindric, slender, blackish purple; staminate spikes 1–3, upper nearly two inches long and pedunculate, the lower sessile and both contiguous and shorter the lowest longer than the last and more remote; pistillate 3, long cylindric, 2–4 inches long, and slender, the upper staminate at the apex and erect; the lowest longer, subremote and subrecurved, short-sheathed and loose-flowered at the base; stigmas two; fruit oblong-obovate, short rostrate, entire at the orifice, with the scale oblong-obovate, pale on the back, with the nerve extended into a *mucronate* point and sometimes making the scale emarginate.

Banks of streams at Santa Barbara, California; *Dr. Parry.* The locality gives name to the species.

No. 267. *C. Thurberi*, Dew.

Spica staminifera solitaria sublonga, terminali squamis oblongis obtusis mucronatis; pistilliferis ternis oblongo-cylindraceis subcrassis vix nutantibus densifloris, infima exserto-pedunculata sublonge vaginata; fructibus *tristigmaticis* ovato-oblongis multi-nervosis brevi-conico-rostratis subventricosis bidentatis squama brevi oblonga obtusa dorso trinervata scabro-aristata longioribus vel basi spicarum brevioribus.

Culm two feet high, erect, scabrous above and smooth below the spikes, towards the root leafy, leafy-bracteate; a single, erect and long staminate spike; pistillate spikes three, cylindric, thickish, dense-flowered, pedunculate, the lowest sheathed and exsert; stigmas three; fruit oblong or ovate-oblong, tapering into a shortish beak, many-nerved, two-toothed and inflated; pistillate scale short-oblong, obtuse, scabrous-cuspidate, and shorter than the fruit except at base of the spikes. Related to C. hystricina, Willd., but remote.

At Mabibi, Sonora, in June; *Thurber.* It bears the honored name of its discoverer, one of the exploring party.

No. 268. *C. Wrightii*, Dew.

Spicis staminiferis 2 (raro 3) oblongo-cylindraceis erectis bracteatis subremotis cum squama oblonga acuta vel inferne aristata;

pistilliferis 2–3 oblongo-cylindraceis, gracilibus remotis sublaxifloris exsertè pedunculatis, suprema apice staminifera, infima longe vaginata exsertaque, omnibus foliaceo-bracteatis; fructibus *tristigmaticis* ovatis subconicis subtriquetris brevi-rostratis subscabris vix ventricosis bilabiatis squama ovato-oblonga cuspidata paulo longioribus vel basi paulo brevioribus.

Culm about a foot high, erect or subflaccid, leafy towards the root, and leafy bracteate; spikes 3–6, oblong cylindric; staminate 2, upper an inch long and pedunculate, the next one-third as long and near it usually, rarely a third which is remotish, and all bracteate; pistillate spikes, commonly 2–3, rarely one, rather remote and pedunculate, the upper staminate at the apex, the lowest longer pedunculate and exsert, all rather lax-flowered especially below; stigmas 3; fruit ovate, sub-conic, slightly triquetrous, short and round, short-rostrate, many nerved, bilabiate and subscabrous, a little longer than the ovate-oblong, rough-cuspidate scale, except at the very base of the spike: color of the plant, dark green.

In woods on the Colorado of Texas; *Wright.* It is honored by the name of its discoverer, another of the exploring party.

This species resembles C. scabrata Schw.; but it differs greatly in its staminate spikes, as well as in the pistillate and the fruit.

No. 269. *C. Schottii*, Dew.

Spicis staminiferis terminalibus 3–5 cylindraceis sæpe geminatis erectis approximatis nigro-rubris, superiori triunciali medio dilatata, reliquis brevioribus sessilibus contiguis vel infima remota et interdum geminata; pistilliferis 3 (raro 4) prolongo-cylindraceis gracillimis 6–8-uncialibus per-laxifloris inequaliter pedunculatis bracteatis, inferioribus longo-pedunculatis vix fructiferis vel abortivis cum squamis oblongis arctis obovatis vix acutis; fructu abortivo vel nimis immaturo *distigmatico;* culmis superne scabris, subprostratis? foliis bracteisque viridi-glaucis.

Culm near 20 inches high, triquetrous and scabrous above, subprostrate, with green glaucous leaves and bracts; spikes 6–8; sometimes staminate 5 and pistillate 3, or 4 and 3, 3 and 3, 3 and 4, most of which are long, and some very long, upper 3 staminate, near and almost geminate and quite variable, the highest 3 inches long and enlarged in the middle, with the dark red scale oblong and obovate, pale on the back; pistillate spikes 3, rarely 4, cylindric, very long, 4–8 inches and very slender, very lax-flowered and unequally pedunculate, the lowest long pedunculate and long vaginate, all leafy-bracteate and with scarcely the rudiment of fruit or else abortive; pistillate scale oblong, narrow-obovate, scarcely acute.

Banks of rivers, Santa Barbara, California; *Dr. Parry.* This species has some affinity to C. Darwinii, Boott, Trans. Lin. Soc., vol. xx, p. 120, but differs much. The prostration of the culms may have been caused by some crushing force, without which the pistillate spikes must have been long-retrocurved, as in C. pendula, Goodenough. It bears the name of another distinguished member of the exploring party.

No. 270. *C. monticola*, Dew.

Spica staminifera solitaria inferne tereti erecta brevi-bracteata cum squamis oblongis obtusiusculis dorso excepto castaneis; pistilliferis binis sub-laxifloris, superiori sessili staminifera contigua, inferiore interdum subremota vaginata exserte pedunculata; fructibus di-tristigmaticis lato-ovatis oblongis convexo-concavis acutiusculis vix rostratis subvillosis nervosis ore integris vel subbifidis squama lato-ovata acuta longioribus vel inferiore mucronata paulo brevioribus; foliis vaginatis culmum superantibus.

Culm 8–10 inches high, scabrous above, leafy; leaves flat, rough on the edge, sheathed at the base and longer than the culm; one staminate ovate spike, with a sessile ovate pistillate spike near it and another pistillate spike subremote, often sheathed and exsertly pedunculate; stigmas *two and rarely three;* fruit ovate, flat, convex above, subacute scarcely rostrate, subvillose and nerved; lower scales of the fruit mucronate and a little longer than the fruit, while the others are acute and shorter than the fruit.

In the cases where the fruit is lenticular while the stigmas are sometimes three, probably one of the stigmas is barren or abortive.

Mountains east of San Diego, California; *Dr. Parry.* This is another of the few species having two stigmas with a single staminate spike.

Note 1.—*C. Umbellata*, Schk., Tab. w. w. w., fig. 171, and its var. *vicina* Dew., vol. x, [1], 31, and vol. xi, [1], 317, this Journ., have been found wide over the country.

The variety occurs also with *two* and *three* pistillate spikes, instead of one, near the staminate, besides the short and somewhat umbellate pistillate spikes near the root of the culm. Mexican Bound. Survey, vol. ii, Part I, p. 232.

Woods on the Colorado and Blanco rivers in Texas; *Wright.* Numerous specimens were brought by the discoverer, of the form given by Schkuhr, and of the variety mentioned; the latter being most common.

C. decidua, Boott, vol. xxvii, [2], p. 78, of this Journal, first found in Tierra del Fuego, afterwards in Sonora, California, by Dr. Parry, is presented fully in Boott, Illust. No. 157, Tab. 170. Dr. Boott shows its still wider range to the north in Oregon.

Note 2.—*C. phyllostachys*, p. 231, Mex. Bound. Surv., is a mistake for *C. Geyeri*, Boott.

ART. V.—*The motions of Fluids and Solids relative to the Earth's Surface;* by W. FERREL, Assistant in the Nautical Almanac Office.

1. UNDER the above title I have published a paper in the Mathematical Monthly, in which I endeavored, by a complete analytical investigation of the motions of fluids surrounding the earth, arising from the different circumstances of a difference of pressure caused by a difference of temperature, combined with the modifying forces arising from the earth's rotation, to give a satisfactory explanation of all the general motions of the atmosphere and the ocean, the cause of the greater barometric pressure of the atmosphere near the tropics than at the equator and the poles, and of the greater pressure generally in the northern hemisphere than in the southern, to account for the motions of revolving storms in both hemispheres, from the equator towards the poles in the parabolic paths, and to establish completely their gyratory character; none of which phenomena had ever been satisfactorily accounted for by any of the theories which do not take into account the effect of the earth's rotation. It has been suggested by several that a paper more popular in its character, although less complete, which should contain only the more essential parts of the analysis, and in which familiar illustrations should supply in some measure the more difficult parts of the analysis, would be more satisfactory to many readers. It is proposed, therefore, in this paper, in consequence of the general interest taken in the subject, to treat it according to this suggestion, and to give only the most essential part of the analysis, showing the influence of the earth's rotation, which being based upon well known principles, instead of being deduced from general fundamental equations, is very simple, but is sufficient for a general understanding of the subject.

I. *The effect of the earth's rotation upon moving bodies at its surface.*

2. If a body were set in motion upon the surface of the earth, supposed to be entirely without friction, it would not in general move in the circumference of a great circle around the earth, but would be continually deflected to one side by a force arising from the earth's rotation.

Let r be the radius of the earth,
θ the polar distance in arc,
φ the longitude, and
n the angular velocity of the earth's rotation.

Then $r \sin \theta$ is the distance of a body on the earth's surface from the axis of rotation, and $r \sin \theta n^2$ the centrifugal force in

the direction of a perpendicular to the earth's axis, arising from the earth's rotation. If in addition to the angular motion common to all bodies at rest on the surface of the earth, the body has an angular motion $D_t\varphi$ relative to the earth, then the centrifugal force becomes $r\sin\theta\,(n+D_t\varphi)^2$. Now if we resolve the preceding force in the directions of the meridian and a perpendicular to it, the part acting in the direction of the meridian, neglecting the small effect of the earth's ellipticity, is $r\sin\theta\cos\theta\,(n+D_t\varphi)^2$. The part of this force which gives ellipticity to the earth's surface, and which is necessary to keep a body at rest on the elliptical surface, and prevent it from sliding toward the pole, is $r\sin\theta\cos\theta\,n^2$. Hence the difference of these two forces, when the body has a motion eastward relative to the earth, is a deflecting force which has a tendency to cause the body to move from the pole toward the equator. The difference of these forces is $r\sin\theta\cos\theta\,(2n+D_t\varphi)\,D_t\varphi$, and hence when the body is entirely free to move in any direction, we have

$$(1.)\qquad r\,D_t{}^2\theta = r\sin\theta\cos\varphi\,(2n+D_t\varphi)\,D_t\varphi.$$

3. Again, if the body has a motion toward or from the pole, it must satisfy the well known principle of the preservation of areas, so that as it approaches the pole, and consequently the axis of rotation, the angular motion must be increased, that is, it must acquire a motion eastward relative to the earth, but if it recedes from the pole, it must acquire a relative westward motion. In order to satisfy the preceding principle, the motion must satisfy the following equation:

$$(2.)\qquad r^2\sin^2\theta\,(n+D_t\varphi) = \text{constant}.$$

Taking the derivative with regard to t we get

$$(3.)\qquad r\sin\theta\,D_t{}^2\varphi = -2r\cos.\theta\,(n+D_t\varphi)\,D_t\theta.$$

4. Equations (1) and (3) determine the motions of a free body on the earth's surface. If the body is constrained to move either in the direction of a meridian or a parallel of latitude only, the deflecting force instead of causing a deflection, causes only a pressure. If we put P for the part of the force or pressure acting in the direction of the meridian, which depends upon the earth's rotation only, and Q for the part depending upon the earth's rotation, which acts in the direction of a parallel of latitude, we have

$$(4.)\qquad \begin{cases} P = 2rn\sin\theta\cos\theta\,D_t\varphi \\ Q = -2rn\cos\theta\,D_t\varphi. \end{cases}$$

In the preceding equations $rD_t\theta$ represents the lineal velocity of the body in the direction of the meridian, and $r\sin\varphi D_t\varphi$ the lineal velocity relative to the earth in the direction of the parallel of latitude. Hence the deflecting force is the same in both directions in the same lineal velocity.

5. If v is the velocity of a body moving in any direction whatever, and F the deflecting force perpendicular to this direction, by resolving the preceding forces and velocities in the direction of v and the perpendicular to it on the right, we get

$$(5.) \qquad F = 2nv\cos\theta.$$

In the northern hemisphere cos θ is positive, but in the southern negative. Hence, we have established this important principle, *in whatever direction a body moves, it is always deflected to the right in the northern hemisphere, and the contrary in the southern hemisphere.*

The forces resolved in the direction of v cancel each other, and hence the velocity is never accelerated or retarded.

6. Since rn^2 represents the centrifugal force at the equator arising from the earth's rotation, and is known to be $\frac{1}{289}$ of g or gravity, the preceding equation may be reduced to

$$(6.) \qquad F = \frac{2v\cos\theta}{289\,n}g.$$

This form of the equation is convenient for comparing the force F with gravity.

7. In the preceding equations rn is the lineal velocity of the equator, and is equal to 1523·2 feet, the second being the unit of time. Hence n=·000072924. Also g=32·2 feet.

It may be remarked here that the preceding deflecting force is not an absolute force, such as would be required to deflect a moving body from a fixed direction in space, but is only relative, being somewhat of the nature of a centrifugal force, and arises from the fact that the direction relative to the earth to which the moving body is referred, is continually changing its direction with regard to fixed directions in space.

II. *The general Motions and Pressure of the Atmosphere.*

8. By the general motions of the atmosphere are meant all those motions produced by a difference of density between the equatorial and polar regions arising principally from a difference of temperature. If the atmosphere in all parts of the earth had the same density, every part would be in a state of statical equilibrium, and its surface and the strata of equal density would assume the elliptical figure of the earth's surface, and consequently the pressure of the atmosphere at the earth's surface would be everywhere the same. But the temperature of the atmosphere being less and consequently its density greater in the polar than the equatorial regions, the greater pressure of the polar regions causes the surface of the atmosphere and the strata of equal density in the equatorial regions to rise a little above the level of equilibrium, and hence the atmosphere in the upper regions flows toward the poles, while the greater pressure of the

polar regions causes a counter current toward the equator in the parts nearer the earth's surface, which would extend down to the earth's surface, if it were not for the modifying causes arising from the friction of the earth's surface, which will be explained. If the earth had no rotation on its axis, this interchanging motion between the equatorial and polar regions would be exactly in the directions of the meridians; but having a rotation, from what has been demonstrated in the preceding section, the atmosphere above in flowing toward the poles acquires an eastward motion relative to the earth's surface, and after descending in the polar regions and flowing back nearer the earth's surface toward the equator, it tends toward the west, and on arriving in the equatorial regions it has a westward motion. If it were not for the resistance of the earth's surface, the mutual actions of the strata upon one another, whatever the initial state of the atmosphere, would cause them to have finally the same east or west motion at all heights in the same latitude, and this motion would be such as to satisfy equation (2), and also, since the mutual actions of the strata upon one another could not affect the sum of the moments, it would be such that the sum of the moments of all the particles would be the same as that of the initial state arising from the earth's rotation and from any initial motion relative to the earth, which it might have had. This latter condition determines the constant in equation (2), which was shown in my paper in the Mathematical Monthly, to which I must refer for the method, to be, on the hypothesis of an initial state of rest relative to the earth, equal to $\frac{2}{3} r^2 n$. With this value of the constant the equation gives

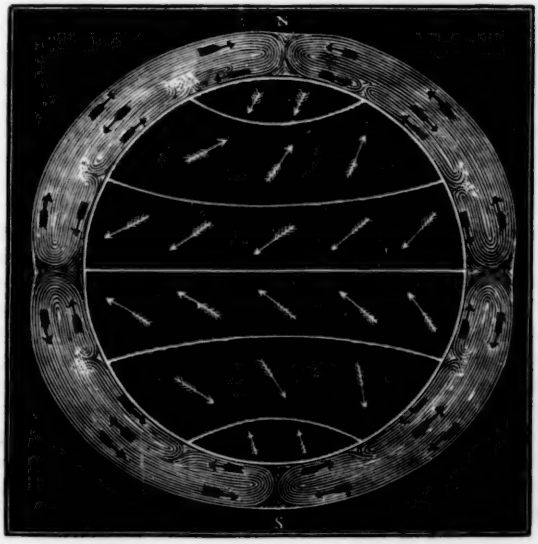
$$(7.) \qquad D_t\varphi = \left(\frac{2}{3\sin^2\theta} - 1\right) n.$$

9. Near the poles, where $\sin^2\theta$ is very small, $D_t\varphi$ and consequently the lineal velocity $r\sin\theta D_t\varphi$ must be very great. Toward the equator $D_t\varphi$ is negative, and hence the motion there is westward. Putting $D_t\varphi = 0$, the equation gives $\sin^2\theta = \frac{2}{3}$, and hence the sine of the latitude where there is no motion east or west is equal to $\sqrt{\frac{1}{3}}$, which answers nearly to the parallel of 35°. Hence between this parallel and the poles the motion is eastward, but between it and the equator, toward the west. From what has been shown therefore in § 2, the eastward motion toward the poles, and the westward toward the equator, since $D_t\varphi$ is negative there, must both cause a pressure toward the parallels of 35°, and consequently an accumulation of atmosphere there, and a depression at the poles and at the equator. The amount of the pressure is represented by the term $r\sin\theta\cos\theta(2n + D_t\theta) D_t\varphi$, and hence toward the pole, where $D_t\varphi$ is very large, this pressure is very great, and at the poles it would

be infinite. Hence at the poles and at some distance from them, on the hypothesis of no resistances from the earth's surface, the atmosphere cannot exist. Between the parallels of 35° and the equator $D_t \varphi$ is less and also $\cos \theta$, and consequently the pressure from the equator and the depression there are comparatively small. It was shown in the Mathematical Monthly that in the case of a fluid surrounding the earth five miles high, the fluid would recede from the poles about 28° and be depressed at the equator about 4000 feet. This, however, is upon the hypothesis that the upward expansion of the atmosphere arising from a greater temperature is insensible.

10. The preceding results, it must be remembered, are all upon the hypothesis that the atmosphere is not resisted in its motions by the friction of the earth's surface. Although these results are much modified by the resistance of the earth's surface, yet they will be of great advantage in explaining its general motions; for as there can be no resistance until there is motion, the atmosphere must have a tendency to assume, in some measure, the same motions and figure as in the case of no resistances. Hence, towards the poles the general motions of the atmosphere must be towards the east, and in the torrid zone towards the west;

1.



but as these motions, in consequence of the resistances, are small in comparison with those in the case of no resistances, instead of the atmosphere's receding entirely from the poles, there must be

only a comparatively small depression there, as represented in the figure, and instead of its being about 4,000 feet lower at the equator than at the place of its maximum height near the tropics, there must be only a very slight depression there, both on account of the small pressure from the equator, and also on account of the upward expansion arising from a greater temperature.

11. That the atmosphere must assume the preceding figure in consequence of the eastward motion toward the poles and westward motion near the equator, will be readily understood from the following illustration. It is well known that if the atmosphere had the same motion of rotation with the earth, that it would assume the same figure. Now, if the whole atmosphere had a greater angular motion, that is, if it had an eastward motion relative to the earth, the increased centrifugal force would evidently cause it to accumulate at the equator and to be depressed at the poles. On the other hand, if it had a less angular motion, that is, a motion westward relative to the earth, it would accumulate at the poles and be depressed at the equator. Hence, since the motion is eastward in the higher latitudes and westward near the equator, it is plain that there must be a depression at both the poles and the equator, and consequently an accumulation having its maximum height at some parallel between.

12. The force which overcomes the resistance of the earth's surface to the east and the west motions of the atmosphere depends upon the term in equation (3) containing $D_t \theta$ as a factor, which depends upon the interchanging motion of the fluid between the equatorial and the polar regions, and hence the term must vanish at the equator and the poles. All the east or west motion of the atmosphere is consequently destroyed by the resistances at these places, and hence as $D_t \theta$ vanishes there also, there is a belt of calms at the equator, called the equatorial calm belt, and there must be also a region of calms about the poles.

13. As the motion of the atmosphere is east towards the poles and west near the equator, somewhere between the equator and the poles there must be a parallel of no motion east or west, which, in the case of no resistance, was determined upon the hypothesis of an initial state of rest, and found to be at the parallel of 35°, (§ 9). In the case of the atmosphere this parallel is entirely independent of the initial state of the atmosphere, and depends in a great measure upon the law of resistance, and hence it cannot be accurately determined. It is evident, however, that the east and west motions of the atmosphere at the earth's surface must be such that the sum of the resistances of each part of the earth's surface multiplied into its distance from the axis of rotation, must be equal to 0, else the velocity of the earth's rotation would

be continually accelerated or retarded, which cannot arise from any mutual action between the surface of the earth and the surrounding atmosphere. Now, as the part of the earth's surface where the motion of the atmosphere is west is much farther from the axis than the part where it is east, the latter part must comprise more than half of the earth's surface, unless the velocity of the eastern motion towards the poles is much greater than that of the western motion near the equator. Therefore, since one-half of the earth's surface is contained between the parallels of 30°, the parallels of no east or west motion at the earth's surface must fall within these parallels, and they are accordingly found on the ocean to be near the tropics. Hence the maximum height of the atmosphere, as represented in the figure, must also be near the same parallels.

14. The increase of pressure arising from the accumulation of atmosphere near the tropics, caused principally by the deflecting forces (§ 5) arising from the more rapid east and west motions of the atmosphere in the upper regions, where there is least resistance, gives the atmosphere a tendency to flow from beneath this accumulation both towards the equator and the poles, since the motions, and consequently the forces, which cause this accumulation, are much less near the surface. But on account of the greater density of the atmosphere towards the poles, it has a tendency also to flow, at the earth's surface, from the poles towards the equator. Between the parallels of greatest pressure and the equator, these tendencies combine, and produce a strong surface current, which, combining with the westward motion there, gives rise to the well-known northeast wind in the northern hemisphere, and the southeast wind in the southern hemisphere, called the trade winds. But between the parallels of greatest pressure and the poles, these tendencies are opposed to each other, and the one arising from the accumulation of atmosphere near the tropics being the greater in the middle latitudes, causes the atmosphere to flow at the earth's surface towards the poles; and this motion, combining with the general eastward motion of the atmosphere in those latitudes, gives rise to the southwest wind in the northern hemisphere and the northwest wind in the southern hemisphere, called the passage winds.

15. Near the poles, the tendency to flow towards the equator seems to be the greater, and causes a current there *from* the poles, which, being deflected westward (§ 5,) causes a slight northeast wind in the north frigid zone, and a southeast wind in the south frigid zone. But this is only near the earth's surface; and the general tendency of the atmosphere in the upper regions must be towards the east, as will be seen.

16. Since the atmosphere near the tropics can have no motion in any direction at the earth's surface, there are calm belts there,

called the tropical calm belts. Near the polar circles, where the polar and passage winds meet, there must also be calm belts, which may be called polar calm belts. The motions of the atmosphere, therefore, at the earth's surface, if they were not modified by the influence of continents, would be as represented in the interior of the figure, in which the heavy lines represent the calm belts. On account of the influence of the continents, these belts are somewhat displaced and irregular, and on account of the varying position of the Sun, they change their positions a little in different seasons of the year.

The southern limit of the polar winds in the northern hemisphere, and also the limit between the trade and passage winds, has been determined by Prof. J. H. Coffin, from the discussion of a great number of observations at different points, and given in a chart, in his treatise on the winds, published in the seventh volume of the Smithsonian Contributions.

17. That the atmosphere is depressed at the equator and the poles, and has its maximum height near the tropics, as has been represented, is indicated by barometrical pressure. It was formerly thought that this pressure, at the level of the ocean, was very nearly 30 inches in all latitudes; but it is now well established that it is much less towards the poles than near the tropics, and also a little less at the equator. Says Captain Wilkes: "The most remarkable phenomenon which our observations have shown is the irregular outline of the atmosphere surrounding the earth as indicated by the pressure upon the measured column at different parts of the surface. Our barometrical observations show a depression within the tropics, a bulging in the temperate zone, again undergoing a depression on advancing towards the arctic and antarctic circles."

Says Sir James Ross:* "Our barometrical experiments appear to prove that the atmospheric pressure is considerably less at the equator than near the tropics; and to the south of the tropic of Capricorn, where it is greatest, a gradual diminution occurs as the latitude is increased, as will be shown from the following Table, derived from hourly observations of the height of the column of mercury between the 20th of November, 1839, and the 31st of July, 1843."

Extract from Ross's Table.

Latitude.	Pressure.	Latitude.	Pressure.	Latitude.	Pressure.
	inches.		inches.		inches.
Equator.	29·974	42° 53′	29·950	55° 52′	29·360
13° 0′ S.	30·016	45 0	29·664	60 0	29·114
22 17	30·085	49 8	29·467	66 0	29·078
34 48	30·023	51 33	29·497	74 0	28·928
		54 26	29·347		

* Voyage to the Southern Seas, vol. ii, p. 383.

18. The following table, first published by M. Schouw, and reduced here from millimetres to English inches, shows that there is a similar bulging of the atmosphere in the middle latitudes and depression at the pole in the northern hemisphere, as has been observed in the southern hemisphere.

Place.	Latitude.	Pressure.	Place.	Latitude.	Pressure.
		inches.			inches.
Cape,	33° 0′ S.	30·040	London,	51° 30′	29·961
Rio Janeiro,	23 S.	30·073	Altona,	53 30	29·937
Christianburg,	5 30 N.	29·925	Dantzic,	54 30	29·925
La Guayra,	10	29·928	Konigsberg,	54 30	29·941
St. Thomas,	19	29·941	Apenrade,	55	29·905
Macao,	23	30·039	Edinburgh,	56	29·851
Teneriffe,	28	30·087	Christiana,	60	29·866
Madeira,	32 30	30·126	Bergen,	60	29·703
Tripoli,	33	30·213	Hardanger,	60	29·700
Palermo,	38	30·036	Reikiavig,	64	29·607
Naples,	41	30·012	Godthaab,	64	29·603
Florence,	43 30	29·996	Eyafiord,	66	29·669
Avignon,	44	30·000	Godhaven,	69	29·674
Bologna,	44 30	30·008	Upernavik,	73	29·732
Padua,	45	38·008	Mellville Isle,	74 30	29·807
Paris,	49	29·976	Spitzbergen,	75 30	29·795

19. From the preceding tables, it is seen that the barometric pressure is much less, especially in the southern hemisphere, towards the poles than at the equator, although the density towards the poles is much greater, and hence the depression there must be considerable.

20. It has been seen (§ 1), that, in consequence of the earth's rotation, the interchanging motion of the atmosphere between the equator and the poles give rise to a force, by which this motion itself is counteracted. For instance, the motion toward the poles in the upper regions causes an eastward motion which gives rise to a force toward the equator, and which, consequently, counteracts the motion toward the poles, and the motion toward the equator produces a westward motion which gives rise to a force acting in the direction of the poles, which counteracts the motion toward the equator. The motion of the atmosphere, therefore, between the equator and the poles, is not produced by the whole force arising from the difference of density between the equator and the poles, but by a small difference only between the two forces. Hence if the earth had no rotatory motion, the force which produces this motion would be very much greater, and there would be a sweeping hurricane from the pole to the equator.

21. It is evident, where the motions of the atmosphere are resisted by the earth's surface, that all the conditions cannot be satisfied by a motion at the surface from the poles towards the equator, and by a counter motion in the upper regions. For we have seen (§ 13,) that the atmosphere at the surface of the earth

must have an eastern motion in the middle latitudes; but it cannot have such a motion, unless it also have a motion toward the poles, in order that the deflecting force (§ 5) arising from this motion may overcome the resistance to the eastern motion. But it is evident there cannot be a complete reversal of the motions in the middle latitudes, but some portion of it must flow toward the poles in the upper regions, else the eastern motion there could not be greater than at the surface, which the conditions require. The motions, therefore, must be somewhat as represented in the figure. The part of the atmosphere next the earth's surface in the middle latitudes having a motion towards the poles, extends to a considerable height, since it generally embraces the region of fair weather clouds, as may be seen by observation.

22. Since the force arising from the eastward motion of the atmosphere above must resist in a great measure the tendency to flow from the equator to the poles, caused by the difference of level arising from a greater upward expansion of the atmosphere near the equator on account of a greater temperature, and since this difference of level, and consequently the tendency to flow toward the poles, must increase with the height, the eastward motion in the middle and higher latitudes must be much greater above than below, and in the trade wind region, near the tropical calm-belts, where the motion is westward below it must be toward the east above. This is also evident from the general consideration, that the whole amount of deflecting force eastward arising from the motion of the atmosphere towards the poles is equal to the deflecting force westward arising from its motion back towards the equator, and that the deflecting force eastward is principally above where there is less resistance than near the surface. Hence, at the top of Mauna Loa in the Sandwich Islands, and on the peak of Teneriffe, both of which places are near the tropical calm-belt at the surface, a strong southwest wind prevails. Hence, also, "on the eruption of St. Vincent, in 1812, ashes were deposited at Barbadoes, sixty or seventy miles eastward, and also on the decks of vessels one hundred miles still further east, whilst the trade wind at the surface was blowing in its usual direction." The eastward motion of the atmosphere above, in the latitudes of the trade winds, is also confirmed by observations made on the directions of the clouds at Colonia Tovar, Venezuela, latitude 10°.26′, as given in the Report of the Smithsonian Institution for 1857 (p. 254). While the motion of the lower clouds was in general from some point towards the east, the observed motion of nearly all the higher clouds was from some point towards the west.

23. From what precedes, the limit between the atmosphere which moves eastward in the middle latitudes and westward nearer the equator, which at the earth's surface is at the tropical

calm belt, must be a plane inclining toward the equator above. And since, according to (§ 21), the atmosphere near the earth's surface cannot have an eastward motion, unless it also has a motion toward the poles, this plane near the earth's surface must nearly coincide with the one which separates the atmosphere moving towards the poles from that moving towards the equator, in the trade wind regions, and hence the latter must also incline above towards the equator. This explains the winds at the peak of Teneriffe, which at the top always blow from the southwest while at the base they blow alternately from the northwest and northeast, changing with the seasons. As the tropical calm belt together with this dividing plane changes its position with the seasons, as will be explained, in the latter part of summer when this plane is farthest north, it still leaves the top of the peak north of it while the base is south of it; and hence the wind at the top always blows from the southwest, even when at the base it blows from the northeast. As this plane moves south in the fall, more of the peak gradually becomes north of it; and hence the southwest wind, which always prevails at the top, gradually descends lower on the sides of the peak until it reaches the base. Hence, when this plane reaches its most southern position, in the latter part of winter, the southwest wind prevails at both the base and the top.

24. The depression of the atmosphere at the poles and at the equator, and the accumulation near the tropics, may be explained in a general manner by means of the principle in (§ 5) that when a body moves in any direction in the northern hemisphere, it is deflected to the right, and the contrary in the southern. The atmosphere towards the poles having an eastward motion, the deflecting force arising from it causes a pressure towards the equator, and the motion near the equator being westward, the pressure is towards the poles; and hence there must be a depression at the poles and at the equator, and an accumulation near the tropics. Since this deflecting force is as $\cos \theta$, it is small near the equator; and, consequently the depression there is small.

25. According to the preceding tables of barometric pressure, there is more atmosphere in the northern than in the southern hemisphere. Says Sir James Ross, "the cause of the atmosphere being so very much less in the southern than in the northern hemisphere remains to be determined." This is very satisfactorily accounted for by the preceding principle; for as there is much more land, with high mountain ranges, in the northern hemisphere, than in the southern, the resistances are greater, and consequently the eastern motions, upon which the deflecting force depends, is much less; and the consequence is, that the more rapid motions of the southern hemisphere cause a greater

depression there, and a greater part of the atmosphere to be thrown into the northern hemisphere.

This also accounts for the mean position of the equatorial calm belt being, in general, a little north of the equator. But in the Pacific Ocean, where there is nearly as much water north of the equator as south, its position nearly coincides with the equator.

For the same reason the tropical calm belt of the northern hemisphere is farther from the equator than that of the southern hemisphere; and, on account of the irregular distribution of the land and water of the two hemispheres in different longitudes, it does not coincide with any parallel of latitude. In the longitude of Asia, where there is all land in the northern hemisphere and the Indian Ocean in the southern, this belt, which is also the dividing line which separates the winds which blow east from those which blow west, is farther from the equator than at any other place, as shown by Professor Coffin's chart.

26. In winter, the difference of temperature between the equator and the poles, upon which the disturbance of the atmosphere depends, is much greater than in summer; this causes the eastward motior of the atmosphere in either hemisphere during its winter to be greater, while in the other hemisphere it is less. Hence a portion of the volume of the atmosphere in winter is thrown into the other hemisphere; but, although the volume or height of the atmosphere is then less, yet, being more dense, the barometric pressure remains nearly the same. The difference at Paris, and in the middle latitudes generally, between winter and summer, is only about $\frac{1}{10}$ of an inch.

On account of this alternate change with the seasons of the velocity of the eastward motion of the atmosphere in the two hemispheres, the equatorial and tropical calm belts change their positions a little, moving north during our spring, and south in the fall.

III. *The Motions of the Atmosphere arising from local disturbances.*

27. Besides the general disturbance of equilibrium arising from a difference of specific gravity between the equator and the poles, which causes the general motions of the atmosphere, treated in the last section, there are also more local disturbances, arising from a greater rarefaction of the atmosphere over limited portions of the earth's surface, which give rise to the various irregularities in its motions, including cyclones or revolving storms, tornadoes, and water-spouts. When, on account of greater heat, or a greater amount of aqueous vapor, the atmosphere at any place becomes more rare than the surrounding portions, it ascends, and the surrounding heavier atmosphere flows in below, to supply its place, while a counter current is consequently pro-

duced above. As the lower strata of atmosphere generally contain a certain quantity of aqueous vapor, which is condensed after arising to a certain height, and forms clouds and rain, the caloric given out in the condensation, in accordance with Espy's theory, produces a still greater rarefaction, and doubtless adds very much to the disturbance of equilibrium, and to the motive power of storms. So long, then, as the ascending atmosphere over the area of greater rarefaction is supplied with aqueous vapor by the current flowing in from all sides below, the disturbance of equilibrium must continue, and consequently the local disturbances of the atmosphere to which it gives rise, whether those of an ordinary rain storm, or a cyclone, may continue many days, while the general motions of the atmosphere may carry this disturbed area several thousands of miles.

28. When the area of rarefaction is such as to cause the atmosphere to flow in below from all sides toward a centre and the reverse above, thus establishing a constantly interchanging motion between the internal and external part, the case becomes very similar to that of the general hemispherical motions of the atmosphere in which the motion is between the polar and equatorial parts. For if the earth's rotation on its axis is analyzed with reference to any other axis, the pole of which is at the distance of θ from the pole of the earth, it is found to have a rotation around this latter axis equal to $n \cos \theta$ (Peirce's *Analytical Mechanics*, § 25). Hence the interchanging motion between the internal and external part in this case must cause the internal part to gyrate around the centre from right to left in the northern hemisphere, and the external part the contrary way, and thus give rise to a cyclone or revolving storm just as in the case of the hemispherical motions the part nearest the pole acquires an eastward motion, and that near the equator a westward motion. This is also evident from the principle demonstrated in § 5, according to which the atmosphere in flowing toward the center below, must be always deflected in the northern hemisphere to the right, and consequently give it a gyratory motion around the center from right to left. In moving out above toward the external part, the deflection tends to give the atmosphere a gyratory motion the contrary way, and hence in flowing out above the gyratory motion which it has while rising to the upper strata in the interior, is not only destroyed but on arriving at the external part it has a gyratory motion the contrary way. In the southern hemisphere, since the deflections there are all to the left of the direction of motion, the gyrations are all reversed, which is the observed law of storms in all parts of the world, as shown by Redfield, and also by Reid, in his *Law of Storms*. It is also evident that at the equator, where $\cos\theta$ vanishes, upon which the deflecting force depends, there cannot be a cyclone, and hence,

of all those which Redfield has investigated, and given in his charts of their routes, none have been traced within 10° of the equator. The typhoons or cyclones, also, of the China sea, have never been observed within 9° of the equator.

29. In the case of the general hemispherical motions the internal or polar part is most dense, but in the case of cyclones the external part. Hence the motions between the centre and the external part are different, in the former case the motion toward the centre being above, but in the latter below. In the case of no resistances from the earth's surface this does not affect the gyrations, since on account of the action of the different strata upon one another, they all eventually have the same gyratory motion. But where there are resistances, they cause the gyrations in the external part to be most rapid above just as in the system of hemispherical motions, they are most rapid above in the internal or polar part.

30. If the gyrations were not resisted by the earth's surface it is evident that the rapid gyrations of the cyclone would cause the atmosphere to recede entirely from the centre, but on account of the resistance the very rapid gyrations are in general in a great measure prevented, so that instead of a complete vacuum the strata of the atmosphere are only somewhat depressed in the interior, as represented in fig. 2. For since the force which produces the gyrations depends upon the velocity of the flow to and from the centre, it is evident, that, at the centre and at the external part of the disturbed portion of atmosphere, where this velocity must vanish, the resistances destroy all gyratory motion. Hence, instead of very rapid gyrations near the centre, as in the case of no resistances, there must be a calm there, and the most rapid gyrations be at some distance from the centre, in accordance with observation. The diameter of the comparatively calm portion, in the centre of the large cyclones, is sometimes about 30 miles. The velocity of gyration of the external part, which, in the case of no resistances, is small, is in a great measure destroyed by the resistances of the surrounding atmosphere, so that it is, for the most part, insensible to observation, and only the more rapid gyrations of the internal part are observed. The motion of gyration combined with the motion at the earth's surface towards the centre, gives rise to a spiral motion towards the centre, exactly in accordance with the observed motions of the atmosphere in great storms or hurricanes, as has been shown by Redfield, in a number of papers on the subject, published in this Journal.

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31. Since the atmosphere is depressed in the middle of cyclones, they must sensibly affect the barometer; and this is the true cause of all the great barometrical oscillations, as was first suggested by Redfield.* As the cyclone approaches, there is generally a very slight rise of the barometrical column, which is at its maximum at the greatest accumulation near the external part of the cyclone, after which it is gradually depressed, until the middle of the cyclone arrives, where the atmosphere is most depressed, when the barometer is at its minimum, and then it returns in a reverse manner to its former height, when the cyclone has passed. In great storms the mercury sometimes falls more than two inches. In oblong storms, and all imperfectly developed cyclones, the same phenomena must take place in some measure, as in a complete cyclone. We have reason to conclude, therefore, that nearly all the oscillations of the barometer are caused by a cyclonic motion of the atmosphere, by which it is depressed in the middle of the cyclones. The cyclones may be very irregular and imperfectly developed, and not of sufficient violence to produce a strong wind, and several may frequently interfere with one another, so that the oscillations may frequently be very slight ones only, and very irregular.

Since the gyratory motion of a cyclone, and the consequent depression at the centre, depend upon a term containing as a factor, $\cos\theta$, (§ 28), which is the sine of the latitude, according to the preceding theory of barometrical oscillation, the oscillations should be small near the equator, and increase towards the poles, somewhat as the sine of the latitude. Accordingly, at the equator, the mean monthly range of oscillation is only two millimetres, or less than $\frac{1}{10}$ of an inch, while there is a gradual increase with the latitude; so that at Paris it is $23{\cdot}66^{mm}$, and at Iceland, $35{\cdot}91^{mm}$. (Kaemtz's *Meteorology*, by C. Walker, page 297.)

32. The greater rarefaction of the atmosphere at some times than at others, without doubt, has considerable effect upon the barometer; but the theory which attributes the whole of the barometrical oscillations to the rarefaction of the atmosphere produced by the condensation of vapor in the formation of clouds and rain, can not be maintained; for according to that theory, in the rainy belt near the equator, where there are always copious rains during the day, which are succeeded by a clear atmosphere during the night, the oscillations of the barometer should be greatest, and towards the poles, where there is little condensation of vapor into rain, they should be the least; but we have seen that just the reverse of this is true. The atmosphere is extremely mobile, so that if there were much difference

* This Journal, [1], xx, 45.

of pressure between one part and the surrounding parts, the equilibrium would be at once restored if the motions toward the centre produced by this difference of pressure, did not give rise to a cyclonic motion, and thus to a centrifugal force combined with the deflecting force arising from the earth's rotation which in a great measure counteracts the force arising from a difference of pressure between the external and internal parts. If therefore the earth had no rotation, the oscillations of the barometer would be no greater in any part of the earth than they are at the equator.

33. When the disturbance of equilibrium is great, but extends over a small area only, the centripetal force is much greater than in the case of large cyclones, and the gyrations are then very rapid and very near the centre, as in the case of tornadoes. Tornadoes generally occur when the surface of the earth is very warm, and the atmosphere calm. For then the strata near the surface becomes very much rarefied, and are consequently in a kind of unstable equilibrium for a while, when from some slight cause, the rarefied atmosphere rushes up at some point through the strata above, and consequently flows in rapidly from all sides below, and then, unless the sum of all the initial moments of gyration around the centre is exactly equal 0, which can rarely ever be the case, it must run into rapid gyrations near the centre, and a tornado is the consequence. This may be exemplified by the flowing of water through a hole in the bottom of a vessel. If the fluid at the beginning is entirely at rest, it runs out without any gyrations; but if there is the least perceptible initial gyratory motion, it runs into very rapid gyrations near the centre.

34. In the case of tornadoes, which are always of small extent, the influence of the earth's rotation in producing gyrations is generally very small in comparison with that of the initial state of the atmosphere, so that the gyration depends principally upon the initial gyratory state of the atmosphere with regard to the centre of the tornado, and may be either from right to left, or the contrary. Hence there may be tornadoes at the equator, although there cannot be large cyclones. In large cyclones the effect of the initial state, except at the equator, is insignificant in comparison with the influence of the earth's rotation; and the latter, moreover, is a constant influence, while the former is soon destroyed by resistances. Hence large cyclones are of long duration, while small tornadoes, depending principally upon the initial gyratory state for their violence, are soon overcome by the resistances.

35. On account of the centrifugal force arising from the rapid gyrations near the centre of a tornado, it must frequently be nearly a vacuum. Hence, when a tornado passes over a build-

ing, the external pressure, in a great measure, is suddenly removed, when the atmosphere within, not being able to escape at once, exerts a pressure upon the interior of perhaps nearly fifteen pounds to the square inch, which causes the parts to be thrown in every direction to a great distance. For the same reason, also, the corks fly from empty bottles, and every thing with air confined within, explodes.

36. When a tornado happens at sea, it generally produces a water-spout. This is generally first formed above, in the form of a cloud, shaped like a funnel or inverted cone. As there is less resistance to the motions in the upper strata than near the earth's surface, the rapid gyratory motion commences there first, when the upper strata of the agitated portion of atmosphere have a tendency to assume somewhat the form of the strata in the case of no resistance. This draws down the strata of cold air above, which, coming in contact with the warm and moist atmosphere ascending in the middle of the tornado, condenses the vapor and forms the funnel-shaped cloud. As the gyratory motion becomes more violent, it gradually overcomes the resistances nearer the surface of the sea, and the vertex of the funnel-shaped cloud gradually descends lower, and the imperfect vacuum of the centre of the tornado reaches the sea, up which the water has a tendency to ascend to a certain height, and thence the rapidly ascending spiral motion of the atmosphere carries the spray upward, until it joins the cloud above, when the water spout is complete. The upper part of a water-spout is frequently formed in tornadoes on land.

When tornadoes happen on sandy plains, instead of water-spouts they produce the moving pillars of sand which are often seen on sandy deserts.

37. The routes of cyclones in all parts of the world, which have been traced throughout their whole extent, have been found by Redfield* to be somewhat of the form of a parabola, as represented in fig. 3. Commencing generally near the equator, the cyclone at first moves in a direction only a little north or south of west, according to the hemisphere, when its route is gradually recurvated towards the east, having its vertex in the latitude of the tropical calm belt. The motion of a cyclone toward the poles may be accounted for by the principle in § 5. The motion of the equatorial side of a cyclone in either hemisphere is always toward the east, and hence the deflecting force causes a pressure toward the equator, but that of the polar side being always toward the west, the deflecting force causes a pressure toward the pole. Now these deflecting forces being as the sine of the latitude, as may be seen from (§ 5), the pressure on the polar side toward

* See this Journal, Second Series, vol. i, Chart i.

the pole is greater than on the other side toward the equator, and hence the cyclone moves in the direction of the greatest pressure. It is not to be supposed, however, that there is an actual transfer of all the atmosphere of a cyclone from the equator to the polar regions. For the motions and pressure of the cyclone being greater on the polar side, where the deflecting forces which cause it are greatest, its action upon the atmosphere in advance of it is greater than on the equatorial side, where these forces are much

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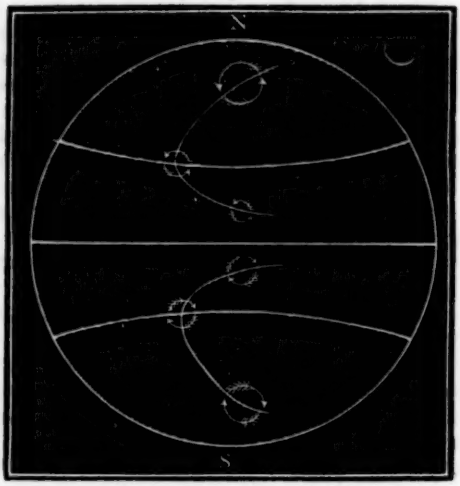

less, and hence new portions of the atmosphere are being continually brought into action on the one side, while the resistance of the earth's surface, and the adjacent portions of atmosphere on the other side, are continually overcoming the comparatively weak forces there, and destroying the gyratory motion of the cyclone; so that the centre of the cyclone is being continually formed in advanced portions of the atmosphere. Since many cyclones are more than one thousand miles in diameter, the difference in the violence of its action on the two sides is very considerable. Hence the interior and most violent portion of a cyclone, always gyrating from right to left in the northern hemisphere, and the contrary in the southern, must always gradually move towards the pole of the hemisphere in which it is. While between the equator and the tropical calm belt, it is carried westward by the general westward motion of the atmosphere there, but after passing the tropical calm belt, the general motion of the atmosphere carries it eastward, and hence the parabolic form of its route is the resultant of the general motions of the atmosphere, and of its gradual motion toward the pole.

IV. *The Motions of the Ocean.*

38. Besides the actions of the sun and moon which give rise to the tides, there are only two causes which can produce any sensible motions of the waters of the ocean. One of these is the action of the atmosphere upon the surface of the ocean, and the other, the difference of density between the water near the equator and that towards the poles, arising from a difference of temperature. The general motions of the atmosphere at the surface of the ocean have a tendency to cause a westward motion of the water in the torrid zone, and an eastward motion in the middle and higher latitudes; and from what we know of the effects of strong winds upon the ocean, we have reason to think that these general motions of the atmosphere are adequate to produce *sensible* motions, since, after the inertia of the water is once overcome, which, however small the force, is only a question of time, the only force necessary is that which is adequate to overcome the resistance of friction, which is very small where the velocity is small. The difference of density between the equator and the poles causes a slight interchanging motion of the water between them, and consequently, where not interrupted by continents, it produces a system of motions in the ocean similar to those of the atmosphere. Hence these two causes of oceanic disturbance, whatever their relative weight, both act in the same directions, and conjointly cause the observed westward motion of the ocean near the equator, and eastward motion towards the poles.

39. The westward motion of the water of the ocean in the torrid zone was first observed by Columbus, and is now well established; and observations also show that there is a motion towards the east in higher latitudes. A bottle thrown into the ocean near Cape Horn was picked up three and a half years afterward at port Phillip, Australia, a distance of 9000 miles, which makes the eastward velocity in that latitude more than 7 miles per day. And Sir James Ross, when sailing eastward near Prince Edward's Island, found himself every day from 12 to 16 miles by observation in advance of his reckoning. (*Voyage to the Antarctic Seas*, vol. ii, p. 96.) But a westward motion being established in the torrid zone, an eastward motion in the higher latitudes must be admitted; for, as was shown in the case of the atmosphere (§ 13), the one cannot exist without the other.

40. It has generally been supposed that the equatorial westward current of the ocean is caused principally by the action of the westward winds there; but Professor Guyot thinks that "it is too deep and rapid to admit of being explained by their action alone," and that "the difference of temperature betwen the regions near the equator and those near the poles controls all other causes by its power and the constancy of its action." (*Earth and*

Man, pp. 189, 190.) The torsive or deflecting force which causes the westward motion of the atmosphere and the ocean in the equatorial regions, and the eastward motion in the higher latitudes, has been shown to be as the velocity of the interchanging motion between the equatorial and the polar regions; and hence if this motion in both were similar, the relative amount of this force in each must be as the whole mass multiplied into the velocity of this motion between the equator and the poles. If we suppose the ocean to be 3 miles in depth, its mass is about 500 times that of the atmosphere, and hence if the motion between the equator and the poles were only $\frac{1}{3}\frac{1}{0}\frac{1}{0}$ of that of the atmosphere, the part of the force which gives it a westward motion near the equator, and an eastward motion towards the poles, arising from this cause, must be greater than that of the action of the atmosphere upon it, since the whole amount of this force in the atmosphere is not spent upon the ocean, but only that part which overcomes the resistances to its motions. Although the effect of temperature in producing a difference of density, and consequently of disturbing the equilibrium, is very much less in the ocean than in the atmosphere, yet since the amount of motion which a given disturbing force will produce where time is not considered, depends as has been stated, upon the amount of the resistances, and not upon the amount of inertia to be overcome; and since the resistances diminish as the square of the velocity, a very small amount of disturbing force arising from a difference of density must be adequate to cause an interchanging motion in the ocean between the equatorial and the polar regions equal to $\frac{1}{3}\frac{1}{0}\frac{1}{0}$ of that of the atmosphere; and hence we have reason to think that a greater part of the motions of the ocean is due to this cause than to the action of the atmosphere upon it.

41. The motions of the ocean being similar to those of the atmosphere, they must cause a slight elevation of the surface about the parallels of 30°, and a depression at the equator and the poles, just as in the case of the atmosphere, except that it will be less in the ratio of the relative velocities of the motions of the ocean and of the atmosphere. If we suppose the east and west motions of the ocean to be $\frac{1}{6}\frac{1}{0}$ of those of the atmosphere at the earth's surface, which would require the maximum eastward velocity in the southern hemisphere to be about 10 miles per day, it would cause the surface of the ocean in the southern hemisphere to be about 15 feet higher at the parallel of 30° than at the pole, and also a little higher than at the equator. Now if the motions which cause this accumulation of water were the same at the bottom of the ocean as at the surface, there would be no tendency of the water to flow out at the bottom from beneath this accumulation; but since the motions there must be much less, it must flow out both towards the equator and the pole, especially

toward the latter, as the depression there is much the greater. Since the density of sea-water does not increase below the temperature of 28°, the density of the ocean does not increase beyond a certain latitude, and hence there is no flow of the water at the bottom from the poles toward the equator, arising from the maximum density at the pole, as seems to be the case in a very slight degree in the atmosphere, but the under current at the bottom, arising from the greater pressure about the parallel of 30°, must extend entirely to the poles; so that there must be a slight tendency of the water to rise at the poles, and flow at the surface some distance towards the middle latitudes. As the water toward the bottom of the ocean is always about the same as the mean temperature of the earth, when it first rises to the surface at the pole, it must be much warmer than it is after it has flowed some distance from it, and hence we have reason to think that there may be open polar seas, surrounded by barriers of ice at some distance from the pole, where there is the maximum temperature of the surface water. A surface current from the poles is indicated by the motions of icebergs in both hemispheres from the polar regions towards a lower latitude.

42. Where the east and west motions of the ocean are entirely intercepted by continents, as in the northern hemisphere, the water receives a slight gyratory motion from left to right. The westward motion of the waters of the Atlantic in the torrid zone, impinging against the continent of America, causes the surface of the water of the Caribbean Sea and the Gulf of Mexico to be a little above the general level, while the eastward motion of the northern part of the Atlantic causes the surface of the water adjacent to the eastern coast of North America, in that latitude, to be a little lower. Hence there is a flow of warm water from the Gulf of Mexico along the coast of the United States toward the lower level about Newfoundland, which, on account of the peculiar configuration of the coast about the Gulf of Mexico, and the peninsula of Florida, gives rise to the Gulf Stream. The eastward motion also of the northern part of the Atlantic causes the surface of the water on the western coast of Europe to be a little *higher* than the general level, while the westward motion in the torrid zone causes it to be depressed, on the western Coast of Africa, a little *below* this level, and hence the water of the eastern side of the Atlantic, flowing from a higher to a lower level, has a motion toward the the equator. The whole of the North Atlantic has therefore a very slight gyratory motion from left to right, and is supposed to make a complete gyration in about three years.

43. A portion of the equatorial current flowing from the higher level of the Caribbean Sea toward Cape Horn causes the Brazil current, which is deflected eastward by the general east-

ward motion of the Southern Ocean. The east side of the South Atlantic, as well as that of the North Atlantic, seems to have a motion toward the equator. Says Sir James Ross, "There is a current from the Cape of Good Hope along the west coast of Africa 60 miles wide, 200 fathoms deep, with a velocity of one mile per hour, of the mean temperature of the ocean." (*Voyage to the Southern Seas*, vol. ii, p. 35.) This cannot be a portion of the Mozambique current from the warm waters of the Indian Ocean, passing around the Cape of Good Hope, and giving rise to the equatorial current of the Atlantic, as has been supposed, but must come from the colder waters of the Southern Ocean. Hence the South Atlantic also has a tendency to assume a gyratory motion, and the equatorial current of the Atlantic is merely the equatorial portion of these two gyrations, with perhaps a small part of the Mozambique current passing around the Cape.

44. The general eastward motion of the water of the northern part of the Atlantic, and the consequent depression of the water next the coast of North America, is the cause of the cold current of water flowing from Baffin's Bay and the east coast of Greenland, between the Gulf Stream and the coast of the United States called the Greenland current. Since the warm water of the Gulf Stream, in flowing northward, is deflected toward the east (§ 5), and that of the Greenland current, in flowing south, tends toward the west, there is no intermingling of the waters of the two currents, but they are kept entirely separate as if divided by a wall, as has been established by the Coast Survey.

45. There must be a motion of the waters somewhat similar to the Gulf Stream and the Greenland current, wherever the great equatorial current impinges against a continent, and the eastward motion toward the poles is interrupted. Hence, on the eastern coast of South America there is the warm Brazil current which has been mentioned, and on the eastern coast of Asia there is the warm China current, flowing toward the north, similar to the Gulf Stream, and the cold Asiatic current insinuating itself between it and the coast, like the Greenland current. On the east coast of Africa, also, there is the Mozambique current flowing south like the Brazil current, and it is also now well established that, east of the Cape of Good Hope, the general tendency of the water is toward the south. This water must mingle with the general eastward current of the South Sea, and hence there is a slight tendency to a gyratory motion in the Indian Ocean also.

46. On the western sides of the continents there is a motion somewhat the reverse of this, and instead of a warm current flowing north, there is a cold one flowing toward the equator, as has been shown to be the case in the Atlantic. Hence, on the west coast of North America there is a flow of colder water

along the coast from the north, and on the west coast of South America is Humboldt's current, much colder than the rest of the ocean in the same latitude, both tending toward the equator to join the great westward current there across the Pacific, and to fill up, as it were, the vacuum which this current has a tendency to leave about the equator, on the west coast of America.

47. With regard to the gyratory motion of the oceans, it may be further added here, that such gyrations are clearly demonstrated by the positions of the isothermal lines, as has been shown by Professor Dana, in a paper read at the twelfth meeting of the American Association for the Advancement of Science (*Proceedings*, vol. xii, p. 77). According to this paper, the isothermal line of 68° F., in winter, extends, in the North Atlantic, from 56° N. on the American side, to 12° N. on the African, and in the South Atlantic, from latitude 31° S. on the South American coast, to 7° S. on the African side. Similar evidences are given of gyratory motions, in a less degree, in both the North and South Pacific, and also in the Indian Ocean.

48. When a portion of fluid on the earth's surface gyrates from left to right, the deflecting force arising from the earth's rotation being in this case toward the interior, the surface assumes a slightly convex form. The water of the North Atlantic having a very small gyratory velocity in comparison with that of the earth's rotation, the interior is a little elevated above the general level, and consequently the pressure upon the bottom increased. Now the gyrations which cause this elevation in the middle being principally toward the top, the increased pressure upon the bottom causes the fluid there to flow out on all sides with a very small velocity, towards the circumference, and hence the water at the surface has a slight tendency to flow in from all sides towards the interior to supply its place. This completely accounts for that vast accumulation of drift and sea-weed, covering a large portion of the interior of the North Atlantic, called the Sargasso Sea. From what has been stated, the North Pacific must also have a slight gyratory motion from left to right, and hence it likewise has its Sargasso Sea.

V. *The Motions of Solid Bodies at the Earth's Surface.*

49. It has been shown that if a body were set in motion upon the earth's surface it would move with uniform velocity, but would be continually deflected to one side. When the range of motion is small, $\cos\theta$ (equations (5)) may be regarded as constant, and hence the deflecting force in this case is constant, and must cause the body set in motion to describe the circumference of a circle. If we put ϱ for the radius of curvature, and m for

the angular velocity about the center of curvature, the centrifugal force of the body is ϱm^2 which must be put equal to the deflecting force, (equation 5). Hence we have

$$\varrho m^2 = 2 n v \cos\theta$$

Also, since v is the lineal velocity of the moving body,

$$\varrho m = v.$$

From these two equations we get

$$\varrho = \frac{v}{2 n \cos\theta},$$

$$m = 2 n \cos\theta$$

50. When the range of motion is so small that $\cos\theta$ may be regarded as constant, ϱ and m are constant, and hence the body then moves with a uniform angular velocity in the circumference of a circle. If we put T for the time of a revolution, we shall have

$$T = \frac{2\pi}{m} = \frac{\pi}{n \cos\theta} = \tfrac{1}{2} \text{ day} \times \sec\theta.^*$$

Hence, since v disappears in the result, T is independent of the initial velocity.

51. If a body is forced to move in a straight line F (equation (6)) is the lateral pressure of that body. If we put $v=60$, which is a velocity of about 40 miles per hour, the equation gives $F = \frac{1}{578} g$, at the parallel of 45°. Hence if a railroad train moves in a straight line 40 miles per hour at the parallel of 45°, the lateral pressure is $\frac{1}{578}$ of its weight, and this is precisely the same in all directions, and not in the direction of the meridian only as has been generally supposed.

52. The deflecting force (§ 5) also causes the gyration of a vibrating pendulum. If the pendulum were suspended at the pole it would evidently vibrate in the same plane in space, and consequently perform a gyration in one day. Since the velocity of the earth's revolution around any other point of the earth's surface is $n \cos\theta$ (§ 28), the time of gyration there is $\frac{1 \text{ day}}{\cos\theta} =$ 1 day $\times$ sec. θ.

53. This same deflecting force may be used to explain some of the motions of a rotating body. Suppose such a body be placed with its axis of rotation in any direction parallel with the horizon. Then the motions of the upper and lower parts being in contrary directions relative to the earth, and the deflecting force in both being either to the right or the left, according to the hemisphere in which it is, gives the axis of rotation a tendency to assume a perpendicular position. But there are other forces beside these horizontally deflecting forces, so that all the forces

* This result was erroneously given in the Mathematical Monthly, 1 day $\times$ sec. θ.

which tend to change the position of the axis would not be in equilibrium with the axis in that position. For the equatorial side then would have a motion coinciding in direction with the motion of the earth's rotation, while the other side would have a motion the contrary way, and consequently the centrifugal force arising from the motion of the earth's rotation, combined with that of the rotating body, would be greater on the equatorial than on the polar side, and give the axis of the rotating body a tendency to move in the plane of meridian. It might be easily shown, when the axis has a position parallel with the axis of the earth, that the forces which tend to change its direction are then in equilibrium, and consequently the axis, if free to turn in any direction, does not change its position.

54. These deductions from theory are in exact accordance with some very delicate experiments made by Foucault with a peculiar form of gyroscope, an account of which is given in this Journal, Second Series, vol. xv, p. 263. See also vol. xix, p. 141.

ART. VI.—*Geographical Notices;* by D. C. GILMAN. No. XV.

ARCTIC EXPLORATIONS.

1. *The Hayes Expedition.*—At a meeting of the council of the American Geographical Society, held November 15, 1860, Henry Grinnell, Esq., presented a letter from Dr. I. I. Hayes dated at Upernavik on the west coast of Greenland, Aug. 14, 1860, and reporting the progress up to that point of the Arctic Exploring Expedition under his command. It will be remembered that the particular object which Dr. Hayes has in view is to determine whether or not there is an Open Polar Sea, as Dr. Kane had good reason to believe. The opinions of Dr. Hayes on this subject are set forth in an article from his pen in this Journal, [2] xxix, 401, and more fully in a small volume entitled "An Arctic Boat Journey," (New York, 1859, 12°, pp. 375).

Dr. Hayes sailed from Boston, July 10, 1860, in a small vessel of 140 tons named the "United States," fitted out by the liberality of gentlemen in New York, Boston, Washington, Philadelphia, and other parts of this country, under the auspices, though not under the official responsibility of the American Geographical Society of New York. Every thing had been propitious up to the time of his writing from Upernavik, and Commander and crew were in excellent spirits in view of their long prospective seclusion from the inhabited world. Dr. Hayes still adhered to his plan of wintering at Cape Frazer (lat. 79° 42′).

The following is his letter:—

Ex. S. United States, Harbor of Upernavik, }
North Greenland, Aug. 14, 1860. }

Gentlemen—I have the pleasure to report for the information of the patrons and friends of the expedition my arrival at this port.

We made a quick passage from Boston. The schooner proved herself to be a good sea boat, and behaved admirably during some very heavy weather. No serious accident occurred.

On the twenty-first day out we were off Godhaven, and on the 5th inst. we anchored in the harbor of Proven. That settlement or outpost in the Upernavik district is forty miles southward from Upernavik. We were there detained in restowing our cargo, so that we might put below, the deck-load of lumber intended for our winter housing, and otherwise better prepare the vessel for the ice encounters. We put to sea again at the earliest practicable moment, and entered this port on the evening of the 12th inst. We found here a Danish brig, belonging to the Royal Company. She will be ready for sea to-morrow, and I shall send my mail by the hands of Dr. Rudolph, the retiring Governor of Upernavik, who returns in her to Copenhagen, and who has politely offered to do me this favor.

Through the kindness and liberality of Mr. Hanson, the Governor of Upernavik, and of Dr. Rudolph, I have obtained at Proven and Upernavik all the dogs that I require, and such furs as are essential to my party. Mr. Hanson and Dr. Rudolph have generously placed at my disposal everything which their personal property or the public stores will afford, for the promotion of the interest of the Expedition.

I have also been fortunate in obtaining the services of an excellent interpreter, Mr. Peter Jonson. He has had much experience in the management of dogs, and is a good hunter. He resides at Tessinsak, sixty miles northward from Upernavik, at which place I shall halt to take on board his team of dogs, which will make, with those on hand, twenty-five.

It is my melancholy duty to report the death by apoplexy, of my carpenter, Gebsen Caruthers. He was found dead in his bunk last Sunday morning. His body was placed in the burial-ground adjoining the church at Upernavik; and I have directed a railing to be constructed around the grave, and a suitable inscription to be placed over it. The loss of Mr. Caruthers is deeply to be regretted. He formerly sailed under Capt. De Haven, in the first Grinnell expedition, and in addition to his experience among the ice and his skill as a workman, he was thoroughly devoted to the best interests of this expedition, and I had great hopes of his future usefulness.

It is impossible for me to predict anything with respect to the prospects before us.

The season has been backward, but the weather has been very mild during the past ten days, and the recent southerly gales have doubtless broken the ice. The wind now blows fresh from the northeast, and if there is much ice before us it will be driven to the southwest.

We shall leave here to-morrow, and attempt at once the Melville Bay passage, and shall hope to make Smith's Strait not later than the 1st of

Sept. If successful in this endeavor, we shall have abundant time to secure a convenient harbor on the coast of Grinnell's Land. You are already aware that I anticipate (from observations made by myself upon this coast in 1854) reaching Cape Frazer, lat. 79 degrees, 42 minutes, where I propose spending the winter. A degree lower, however, will place one within practicable reach of my proposed field of exploration. If the condition of the ice will permit, I will immediately—after a winter harbor has been selected—carry forward the boat which I intend using for next summer's labors, and some provisions, as far north as possible, and then leave them, secured against the bears, and return to the schooner after the winter has firmly set the ice. Early next spring, we shall push forward advance depots, and should we find either ice or water, we shall endeavor to accomplish with boats or sledges, or with both, the chief object of the voyage before the close of the summer. If this fortune awaits us, we shall then return home without unnecessary delay. I do not, however, anticipate this result, but I expect that we shall be detained two winters.

I shall endeavor by every means to avoid a third year's absence. We carry with us, however, food and fuel for that period, and in the event of our being so long detained I do not fear adverse results. With the fresh supplies we have on board I believe we can resist the scurvy.

I do not hesitate to express my belief that, although we are late, we are in season. Capt. Inglefield left this port on the 16th of August, 1852, and the important results which he achieved during the following month in Smith, Jones and Lancaster Sounds, are well known.

I am informed by Governor Hanson that the whaling fleet did not succeed in passing Melville Bay this year, but you are aware of the fact that after a certain period it would be useless for them to succeed; August is the most open month of the year.

I shall however avoid every unnecessary risk of being caught by the winter in the middle of the ice. Should the prospects of success appear to be peculiarly discouraging, I shall return southward and winter at one of the Danish settlements.

My party are in excellent spirits, and earnest in the performance of their duties, and you may rest assured that no effort will be spared to accomplish the object of our undertaking in the shortest possible time. To favor this, we have every facility which experience has indicated.

Our camp equipments are of the most compact and portable description. The food prepared expressly for the expedition by the American Desicating Company in New York, consisting of soup, beef and potato, is excellent, and fully equals my expectations. Of this food we have three thousand pounds—equal to about thirty thousand pounds of the raw material. I have tried it during the passage, and consider the several articles united preferable to the ordinary pemmican. Pemmican of the finest quality may at any time be made of our beef by the addition of lard, of which we have an abundant supply. With good and sufficient food, with every essential for the promotion of health and comfort, with united and earnest companions, and with a vessel well suited for the service, I have, upon leaving this last outpost of christian settlement, every reason to feel greatly encouraged and to expect success.

Trusting our lives and fortunes to the keeping of Him who alone is omnipotent, we sever in a few hours our connection with the civilized world, and enter upon our work, looking hopefully to the future.

With the best wishes for the prosperity of you and yours, and with many sincere thanks for the liberality which you and your associates have displayed in our outfit and preparation, I beg you to believe me,

With great regard your obedient servant,

ISAAC I. HAYES.

To Henry Grinnell, Esq., of New York; Richard Baker, Jr., Esq., of Boston; Prof. A. D. Bache, of Washington; Wm. Parker Foulke, Esq., of Philadelphia, and others who contributed to the Expedition.

Almost simultaneously with the receipt of this letter, Dr. William Longshaw, Jr., of East Cambridge, who had left this country with Dr. Hayes as Surgeon to the Expedition, arrived in Boston, having been compelled to return on account of injury to his eye-sight which rendered him nearly "snow-blind." He brought intelligence from Dr. Hayes a few days later than the date of the above letter, and has also communicated to the newspapers of Boston, many interesting details respecting the early part of the voyage, which the limits of this Journal will not allow us to reprint. The expedition sailed from Upernavik, August 14th, for Tessinsak where it had arrived on the 23d of that month. It was here that Dr. Longshaw parted from the company. Dr. Hayes found a small village of Esquimaux at Tessinsak (the home of his interpreter,) some of whom were employed to make up into clothing the furs purchased at Upernavik.

2. *Hall's Search for the Relics of Franklin's Expedition.*—A short time previous to the departure of Dr. Hayes, Mr. C. F. Hall of Cincinnati, conceived the project of searching for further remains of the Franklin expedition. About the first of June, 1860, he set out from New London, in a whaling vessel named the "George Henry" belonging to Messrs. Williams & Haven of that port. A letter just received from him dated at Holsteinberg, Greenland, July 17th, was communicated to the American Geographical Society by Mr. Grinnell, at the meeting above referred to. In respect to the plans and outfit of Mr. Hall we are happy to publish the following information, communicated in a private letter from Henry R. Bond, Esq., of New London, in answer to enquiries which were addressed to him on the part of this Journal.

"New London, Nov. 20, 1860.

* * * Mr. C. F. Hall is a printer who has resided at Cincinnati. He has had no experience whatever as an Arctic explorer, but has always felt interested in northern voyages of discovery and has particularly turned his attention to the various expeditions sent out in search of Sir John Franklin. On the return of M'Clintock's Expedition, he conceived the idea of fitting a

small vessel and sailing for King Williams Land (where the various Franklin relics were discovered) with the hope of finding some of Franklin's men, still living among the Esquimaux of that region. Being unable to secure funds sufficient for this purpose, he changed his plans and after an interview with Capt. Buddington of this place who was about to sail north on a whaling voyage, he decided with the consent of the owners, to take passage on the "George Henry," (Capt. B.'s ship) and pass the coming winter at that vessel's winter quarters in Cumberland Inlet—there to accustom himself to the climate, and as far as possible, to acquaint himself with the Esquimaux language, and habits of living, which latter he intends to adopt. In the spring he proposes to start in a boat (which he had prepared, and took with him for that purpose) with half a dozen or more picked natives, and plenty of dogs, for King Williams Land. His boat is so arranged, that it can be placed on sledges, so that he can make his way along, by land or water, as required.

After leaving Cumberland Inlet, he will either follow up the east coast of Fox Channel (yet unexplored between 66° 30′ and 70°) to the Straits of the Hecla and Fury, and thence southward and coastwise, until he reaches King Williams Land;—or he will cross Fox Channel at about 66°, thence across Rae Isthmus, by sledges to Committee Bay, and so on by water to his destination. He does not expect to have any white companions, but hopes to be able so to *Equimaux-ise* himself as to be able to communicate personally with, and make himself at home among, such natives as he may meet. He intends to be absent two or three years, during which time he expects to examine carefully King Williams Land, and the main land south, about Great Fish river, for relics of Franklin's Expedition, as he thinks it was not thoroughly explored by Rae or M'Clintock; and he will make particular search among all the natives of that region, for such of Franklin's men as may be still living. Hall takes with him such scientific instruments as he may need, a quantity of provisions, articles of trade for the natives and a full supply of ammunition on which latter he will mainly depend for his subsistence. His expenses are paid by contributions from individuals in Cincinnati, Philadelphia and New York. Messrs. Williams & Haven give him his passage in their "George Henry" to the whaling ground and he expects to make his way back to that point and return home in some whaler when his mission is accomplished.

Hall is physically rather a fat, heavy man, but is full of enthusiasm, pluck and spirit. His enterprise is a very daring one; still if he finds himself able to endure the climate, and the Esquimaux mode of living, he may accomplish something. If he reaches King William's Land in good condition, his chances of discovering other relics seem good." * * *

From Mr. Hall's letter to Mr. Grinnell we present a few extracts.

Holsteinberg, July 17, 1860.

"Our voyage thus far has been attended with calms, fogs and head winds, thus prolonging it to 39 days. The usual time may be set down at from 25 to 30. We arrived here in Holsteinberg harbor on the morning of July 7. The Rescue, of your first expedition in search of Sir John Franklin, in 1850, arrived at midnight of July 11. The George Henry and Rescue parted company the third night out, during a heavy wind; but Holsteinberg being the rendezvous, each vessel made its course direct here.

My health is excellent—better than ever. I enjoy myself beyond measure.

In this connection, I must speak to you of the coöperation I receive from Capt. Buddington, who has the command of both the George Henry and Rescue. If I could have had the choice of 10,000 men, excellent navigators in the waters of the north, and withal good and true men, I could not have selected a better one than Capt. Sydney J. Buddington. The house of Messrs. Williams and Haven, whose generosity in behalf of my voyage to the north should ever be remembered, know well that their interests in the George Henry and Rescue are in the hands of one of the most careful seamen that comes here in the Arctic seas.

It gives me pleasure, also, to communicate respecting the attention and hospitality extended to me by Gov. Elberg of Holsteinberg.

He, in company with the European ladies of Holsteinberg, have spent several hours on board the George Henry, and in nothing do they seem more interested than in examining the records of the first and second Grinnell Expeditions of 1850–'51, and 1853–'54–'55, as written and illustrated by the lamented Kane. Happily, I had these volumes with me. The Governor was also interested in the work of Captain (now Sir) F. L. McClintock. At a tea-party given by the Governor on the evening of July 10, I was invited to give a general statement of the accomplishments by McClintock, in his last voyage here to the Arctic regions. All were much amazed with the jovialness of Gov. Elberg, in reading before the whole company present McClintock's account of his gift of some coals to "the priest's wife, who was blue with cold." "The priest's wife," Mrs. Kier, was one of the party and seemed to enjoy the joke quite as well as any of us.

I must take the only copy of McClintock I have with me, as there are many statements in it that I wish to investigate personally, when on King William's Land next year.

I have visited various mountains of Greenland during our stay here, and know of no part of the world where there is better opportunity for the geologist to investigate the stratification of the earth's crust than here in the north. By the by, Gov. Elberg has presented me with numerous specimens of fossil fish, from North Strom Fiord, the only place where they can be obtained. Mr. McClintock says they are interesting as being of unknown geological date.*

Before me, on the table in my cabin, where I am writing this, is a beautiful bouquet of Arctic flowers, in great variety, sent me by several young Esquimaux ladies of Holsteinberg. I am astonished at the profuseness of Nature's productions here.

* See this Journ. [2], xxi, 313-338 and xxvi, 119, for age of Arctic rocks.—Eds.

July 18.—It is intended that we leave here at the earliest moment. Yesterday, by the assistance of Gov. Elberg and Capt. Buddington, I purchased an excellent team of sledge dogs. Next winter will find me half Esquimaux, I doubt not. Capt. Buddington intends finding good quarters for the George Henry, then proceeding with me through Frobisher's Straits and Fox Channel. Circumstances will decide as to penetrating also Repulse Bay. I shall learn much practical information this winter.

July 23, 1 *o'clock*, A. M.—A fresh breeze now prevails. We are now off for the west side of Davis's Straits."

P. S.—Since the foregoing was in type, a later letter has been received by Mr. Grinnell from Mr. Hall. It is written from his proposed winter quarters, lat. 62° 51′ 30″ N., long. 65° 04′ 45″ W., but the day and month are not specified. Hall had lost his expedition boat, but was in good spirits, hoping to prosecute his journey early in the spring. He claims to have discovered that Frobisher's Strait is not a strait but an inlet.

3. *Capt. Parker Snow's Proposal to Search for the Franklin Relics.*—A brief allusion has already been made in this Journal to the desire of Capt. Parker Snow of the British Mercantile Marine, to go in search of the records and other memorials which it is hoped may still be in existence, as relics of the lost Franklin expedition. At the Oxford meeting (1860) of the British Association he presented his views at some length, and his paper together with a report of the comments which it called out, an introduction and an appendix, has been recently published in a pamphlet form. (London, E. Stanford, 1860, 90 pp., 8vo.) Capt. Snow argues with much earnestness that all the information thus far gathered in respect to the fate of Franklin's party indicates that further traces of the expedition must still be in existence near King William's Land, and the peninsula of Boothia. He even thinks that survivors of the party may still be found. Holding these opinions, he desires to go on the search, and appeals to the British public for aid to the amount of £3500, which he thinks will be sufficient to equip a small vessel (say from seventy-five to ninety tons) and maintain a sufficient crew during a period of two years. He states his desire to enter the Arctic seas, through Behring's Straits, hoping to reach King William's Land the first summer.

A writer in the Tribune informs us that on account of inability to raise the funds which he hoped for, Capt. Snow now proposes a well-equipped boat-party, to leave England in the early spring, and reach King William's Land from the East, the sum already collected being sufficient to fit out such a party.

4. *McClintock's Arctic Soundings.*—The London Athenæum for November 17, 1860, contains the following letter from Capt. McClintock, giving some particulars in respect to his attempt to

make a line of deep sea soundings from Cape Farewell, the southern point of Greenland, to Ireland.

"Bulldog, near Rockall, Nov. 6. }
"Closed at Killybeg's, Nov. 11. }

"*My dear Collinson*,—We have nearly brought to a close about as *tough a job* as usually falls to the lot of the most hardworking—*even of surveying ships*. I have been up (in the ship) to the head of Hamilton Inlet, but South Greenland we found enveloped in an unusual amount of pack, so much so that I had to go up to Godthaab (64° north) before I could get into any harbor. On the 29th of September I succeded in getting into Julianshaab, where I expected to find the Fox, but could obtain no intelligence whatever respecting her. Our vessel was the *earliest* to arrive there this season; the ice having been impenetrable. The Fox (with Capt. Allan Young, Col. Shafner and Dr. Rae on board) had not arrived at Hamilton Inlet on the 17th of September, and I fear she has been detained by ice on the east coast of Greenland, although in a letter Young left for me at Reikiavik he says he intended going *first* to Julianshaab, to obtain an interpreter for the east coast. We have had desperate weather since the beginning of October. A gale on the 8th of October almost crippled us; we lost two boats, had our bowsprits snapped off by a sea, but as the gammoning held it fast, he has since been 'righted,' and at least *looks* shipshape. The iron tiller was also broken, and a vast deal of damage done to the sponsons, paddle-wheels, bulwarks, &c., lying to under bare poles for thirty hours, sleet aloft, and seas coming over us below, unable to cook, &c., disagreeable enough even for a '*Polar*.' To accomplish a line of soundings from Cape Farewell to Rockall, has proved rather beyond our powers at this late season, and with such continued severe weather; yet we have sounded at intervals the whole way, and I think sufficiently for ordinary purposes. Southwest of Iceland, where we expected 2,000 fathoms, we only found 748 fathoms, and in 1,260 fathoms we brought up a living star-fish! I tried in July, August, September and October, yet could not approach Cape Farewell from the southwest, within forty-five miles, the intermediate space being close pack; but at the same time the present is such a bad year that the Danes in Greenland say that they have not had one like it for nearly thirty years. It has been very favorable in Labrador, and very little ice is seen there. In Iceland also, the summer has been very fine. We have had much more icework than I expected, and the ship has suffered accordingly; paddle-arms bent, cutwater chafed away, and copper bolts standing out; the ship rolls very heavily, and is now quite *eager* for a good caulking. I think we have done our work well; at least we have done all we can. Instead of a deep channel leading into Hamilton Inlet, I doubt if forty-five fathoms can be carried inside the outer Islands, and would reduce the width of the main channel to about five miles, and there is an exterior bank along that part of the coast, having between 100 and 200 fathoms water on it. * * I have completed the soundings across to Rockall, but they are at long intervals, and not as straight in line as they would have been under more favourable circumstances of weather. I obtained deep water again inside of the Rockall Bank, 1,310 fathoms about mid-

way. * * The same southeast wind is still blowing which has scarcely ceased since the 18th of October.—Most sincerely yours,

"F. L. McClintock, R. N."

Heuglin's Search for Dr. Vogel, in Central Africa.—The fate of Dr. Edward Vogel, who set out in 1853, under the patronage of the British Government, to coöperate in the explorations of Central Africa then already undertaken by Richardson, Barth, and Overweg, has remained until the present time shrouded in complete mystery. This brave young man, the third son of Dr. Charles Vogel, a distinguished School Director in Leipsic, landed at Tripoli on the 7th of March, 1853, (his twenty-fourth birth-day) and began his African researches. On the first of January, 1856, he set out from Kuka, on the western shore of Lake Tsad intending to return to Europe by way of Wadai, Darfur, Kordofan and the Nile. The items of intelligence which have since been gathered from various sources give reason to believe that he reached the capital of Wadai, *Wara*, and that he was beheaded by the Sultan of that land, although indeed there is a possibility that he is still imprisoned in that country. Every effort to gain more definite information has hitherto failed.

By the kindness of Dr. A. Petermann, of Gotha, the editor of the Geographische Mittheilungen, we have been informed of a noble project, recently put forth, for enlisting the people of Germany in a special expedition, of which the object will be to determine if possible the fate of Dr. Vogel, to recover any remains which may be in existence of his journal and observations, and to prosecute those geographical and scientific inquiries to which his life has in all probability been an offering.

Fortunately the right man is known for this bold and difficult enterprise. Mr. Theodore von Heuglin, for seven years Austrian Consul at Chartum on the Nile, a traveller and observer whose writings are well known in geographical literature, stands ready to go forth in search of tidings of his countryman. A committee of which the Duke of Saxe-Coburg-Gotha is the President, Justus Perthes the Treasurer, and Dr. Petermann the Secretary, has recently been organized, and is diligently engaged in enlisting the sympathies and securing the aid of liberal Germans in promoting researches which the dictates of humanity as well as the interest of science so loudly call for.

From the various circulars which this committee have put forth, we gain the following additional particulars. Mr. von Heuglin is said to be qualified for his proposed task in all the most important requisites of an African explorer. He is accustomed to the climate, acquainted with the languages and habits of the natives, skilled in astronomical and geographical observations,—a good draughtsman, and by his previous residence and travels in Africa known to many influential persons.

Mr. von Heuglin proposed to leave Europe last autumn, and since in Cairo and Chartum he is acquainted with trustworthy servants and has a supply of scientific instruments, he will make the Nile lands the basis of his enterprise, endeavoring at the same time, to have reserved supplies at Bengasi, a town on the North African coast which has direct commercial relations with Wadai. He proposes, if pecuniary resources allow, to secure the services of a botanist as a companion. It is thought that three or four years will be occupied by the expedition, and that its entire cost, in addition to the private resources of the explorer, will fall between twelve and twenty thousand thalers. At the date of our last advices about one third of the necessary amount had already been secured, wholly from the German compatriots of Heuglin and Vogel. As the enterprise is regarded in "the fatherland" as an expression of national union in the advancement of science, we cannot but hope that among the adopted citizens of this country from Germany, so many of whom have acquired ample fortunes, there will some men of liberality be found ready and eager to aid in carrying forward a project which is full of promise.

Medical Statistics of the U. S. Army.—The Surgeon General of the U. S. Army, Gen. Thomas Lawton, has recently presented to Congress a statistical report on the sickness and mortality of the United States Army, between Jan. 1855, and Jan. 1860, prepared by Dr. R. H. Coolidge, Assist. Surg. U. S. A. Although this document is chiefly devoted to sanitary discussions, it is of great value to the student of the physical characteristics of this continent, from the light which it throws on the geographical distribution of various forms of disease.

Two such reports have previously been printed, the first covering a period of twenty years, from 1819 to 1839, and the second a period of sixteen years, from 1839 to 1855. This may be considered accordingly as a supplement or continuation, the general arrangement before adopted being still adhered to, that is, the details being arranged in geographical divisions and regions having similar climatological features.

The volume is accompanied by an outline map of the United States, on a scale of 1 : 10,000,000, being unincumbered with the ordinary topographical details, and political divisions,—it presents to the eye in a very clear and satisfactory manner the limits of the seven military departments of this Government, the East, the West, Texas, New Mexico, Utah, Oregon and California, and also indicates the site of all military posts, both forts and arsenals throughout the entire country.

Squier's Collection of Original Documents concerning the Discovery of America.—Mr. E. G. Squier, well known

for his archæological attainments and his printed works in reference to the early history of America, has announced the publication of a series of papers, chiefly from the Spanish archives, concerning the discovery and conquest of America, which he proposes to issue in the original, with translations, illustrative notes, maps and biographical sketches. The materials for the series have been collected, partly from the Spanish archives, and partly from Central America, during a period of ten years' study of American archæology. The scheme is deserving of the utmost encouragement, as under any circumstances it must appeal to a limited circle of students. The collection will be indispensable to the geographical or historical student, and an honorable companion and supplement to the great collections of Ternaux-Compans, Munoz and Navarrete. The proposal of Mr. Squier to print the original document as well as the translation in every case, will meet with universal acceptance. The first volume of the series, containing Palacio's description of Guazacapan, Izalco, Cuscatlan, Chiquimula, in 1576, has already appeared. Subscriptions for this and the subsequent volumes may be addressed to the Editor, Mr. E. G. Squier, 205 East Tenth Street, New York.

Among the manuscripts collected for publication are the following:

I. Carta dirijida al Rey de España por el Licenciado Don Diego Garcia, de Palacio, Oydor de la Real Audiencia de Guatemala, año 1576.

Report on the Provinces of Guazacapan, Izalco, Cuscatlan, and Chiquimula in the ancient Audiencia of Guatemala, with an account of the languages, customs, and religion of the aboriginal inhabitants, and a description, the first ever given, of the Ruins of Copan. *Original Spanish, Translation and Notes, with a Map.*—(Ready.)

II. Relacion del Descubrimiento y Conquista de las provincias de Nicaragua, dirijida al Rey de España, por el Capitan Gil Gonzalez Davila, desde la Ciudad de Santo Domingo de la Isla Española, 6 dias del mes de Marzo, de 1524 años.

Gil Gonzalez Davila was the first discoverer and conqueror of Nicaragua, and this is an account, under his own hand, of the circumstances of its reduction, and of the character of the country and its inhabitants. Although largely used by Oviedo, Peter Martyr, and Hererra, it has never been published.

III. Cartas del Adelantado Don Pedro de Alvarado, escrita al Rey de España y al Capitan Hernando Cortez, sobre la Conquista y Pacificacion de los Reynos de Guatemala, y la Expedicion que hizo desde el Puerto de Iztapa á Peru, etc.

These letters of Don Pedro de Alvarado, the celebrated Lieutenant of Cortez in Mexico, the Conqueror and afterwards Royal Governor of Guatemala, are seventeen in number, of which three only have been printed. They give an account of the reduction of the rich and powerful Kingdoms of the Zutugils, Quichés, and Kachiquels of Guatemala, and also of his campaign against the Pipils of Cuscatlan (now San Salvador), and his Expedition to Peru.

IV. Relacion muy circumstanciada, escrita al Rey, de los sucesos de Juan Vasquez de Coronado, en las Provincias de Nuevo Cartago y Costa

Rica en la Pacificacion y Descubrimiento de ellas, por el Cabildo de la Ciudad y Provincia de Costa Rica, en 12 de Diciembre, 1562.

A very circumstantial relation to the King of the proceedings of Juan Vasques de Coronado, in the Provinces of New Cartago and Costa Rica, and in their reduction and pacification, by the Municipality of the City and Province of Costa Rica, December 12th, 1562.

V. Relacion dirigida al Rey por Pedrarias Davila, de las Tierras, Costas y Puertos que estaban descubiertos en el Mar del Sur, desde la Villa de Bruselas que estaba poblado en el Golfo de San Lucar, hasta Neguepio que por otro nombre tambien se llamaba Cuzcatan, distancia de 200 leguas; año 1529.

Relation to the King of Spain, by Pedro Arias de Avila, concerning the lands, coasts, and ports which have been discovered in the South Sea, from the city of Brussles in the Gulf of San Lucar, to Neguepio, called also Cuzcatan, a distance of 200 leagues. Dated in the year 1529.

VI. Relation que en el Consejo Real de las Indias hizeo el Licenciado Antonio de Leon Pinelo, Relator de su Alteza, Sobre la Pacificacion y Poblacion de las Provincias del Manché i Lacandon, que pretende hazer Don Diego de Vera Ordoñez de Villaquiran, Cavallero de la Orden de la Calatrava, etc.; año 1638.

This is an account drawn up by the celebrated Antonio Leon Pinceo, author of the "Tratado de Confirmaciones Reales, etc," in his capacity of historical Secretary or reporter to the Council of the Indias, on the remarkable and even now but little known district, occupied by unconquered Indian tribes, which lies between Guatemala, Chiapa, Tabasco, and Yucatan. It gives a comprehensive summary of all that was known of this wide region and its inhabitants, at the time Pinelo wrote, and seems to have been compiled from original, and, as yet, unpublished, documents in the Archives of the Indies. These *relaciones* or Briefs were for the use of the Council exclusively, and only enough were printed to give a copy to each member. Probably no copy of the present document exists, except the one under notice, which seems to have belonged to Pinelo himself, as may be inferred from the MS. corrections and emendations which it bears, and which appear to have been made by his own hand.

VII. Carta dirijida al Rey de España sobre la Conquista y Pacificacion de la Provincia de Yucatan y sus poderosos Reyes, por el Fray Lorenzo de Bienvenida; año 1548.

VIII. Relacion de la Provincia de Honduras é Higueras, por el Obispo Don Cristoval de Pedraza, Obispo de Honduras, dirijida al Emperador, desde el puerto de Truxillo, con fecha de primero de Mayo, año 1547.

IX. Descripcion de las Islas Guanajas; parte de un Informe hecho en 1639, de orden del Presidente de Guatemala, por Don Francisco de Avila i Lugo, Gobernador i Capitan General de Honduras.

X. Relacion de la provincia y tierra de la Vera Paz, y de las cosas contenidas en ella, como son montes, fuentes, animales, aves, y plantas y arboledas, del numero de los pueblos y distancia de la Iglesias y fundacion de ellas, y de lo que cada uno tiene; y finalmente del numero de gente, sus lenguas, su policia y Xpiandad, desde el año de 1544, hasta este de 1575.

XI. Discurso de Felipe de Aniñon, sobre las utilidades y ventajas que resultarian de mudarse la Navegacion de Nombre de Dios y Panama al Puerto de Cavallos y Fonseca, año 1565.

Etc., etc., etc., more than one hundred in number.

ART. VII.—*Researches on the Platinum Metals;* by WOLCOTT GIBBS, M.D., Prof. of Chemistry and Physics in the Free Academy, New York.

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§ 1.

THE material which formed the subject of the present investigation was chiefly obtained from the United States Assay Office and from the Philadelphia Mint, and I am indebted for it to the kindness of Dr. Torrey and of Prof. Bache. Messrs. Cornelius of Philadelphia have also liberally presented me with about 600 grammes of the Siberian osmiridium—a supply which has been of great assistance and for which I desire to express my thanks. The samples obtained from the mint at different times and which had been subjected to different preliminary processes, varied greatly in appearance. In some cases the ore was in distinct scales rather whiter than the Siberian osmiridium; in a sample of this kind Dr. Genth detected distinct crystals, belonging to the rhombohedral system. Other specimens resembled a fine grey metallic sand, while others again (obtained from the sweepings of the Assay Office) presented a heavy grey powder. Nearly all the ores contained more or less iron mechanically mixed which could be extracted by the magnet or dissolved out by acids. Nitro-muriatic acid in particular acted powerfully upon many specimens, dissolving portions of the platinum metals as well as iron and even so far attacking the osmiridium itself as to occasion a distinct evolution of free osmic acid. In California the ore is, I believe, almost always associated with gold, from which it is of course impossible to separate it by washing. At the Assay office, in this city, the gold is melted with twice its weight of silver and the osmiridium allowed to settle. When the gold alloy is poured off, there remains a mass containing nearly all the osmiridium mixed with gold. This mass is fused repeatedly with silver and the last traces of silver and gold are finally removed by treatment with nitric and nitro-muriatic acid and washing. The osmiridium is sold to the manufacturers of gold pens who extract from it the excessively hard particles which serve for the points of pens: the rest is returned to the assay office. The amount of osmiridium obtained in this way does not exceed a few ounces in every million of dollars, and many samples of gold are entirely free from it. It cannot however be doubted that large quantities of the ore will be obtained whenever important practical applications of the metals contained in it shall create a demand.*

* Dr. Torrey has kindly furnished me with the following notes on the Californian osmiridium. "For the first year or two after the establishment of the United

The density of the osmiridium obtained from California varies greatly in different samples: in one specimen, composed of large dull white plates but slightly acted on by nitro-muriatic acid, the specific gravity as determined by Rose's method was found to be 19·352. No very definite conclusions can be reached however from such determinations, since, as Berzelius has remarked, the separate scales or grains have probably very different compositions. According to G. Rose, the density of the Siberian ore varies from 19·3 to 21·1. Dr. Torrey has found among the scales of the Californian ore some which could be flattened under the hammer; these were probably platin-iridium. In general, however, the scales are not malleable; some of a lead gray or bluish tint being with great difficulty cut by the emory dust employed by the gold pen makers. In color the scales vary from nearly silver white to dark gray.

§ 2.

The resolution of the ores of iridium, osmium, etc., and the separation of the different platinum metals from each other, have as is well known always been considered as among the most difficult problems with which the chemist has to deal. Though the researches of Wollaston, Berzelius, Wöhler and other chemists have thrown much light on the subject, and though Claus, in particular, in his elaborate "Beiträge zur Chemie der Platin-Metalle" has done much to free the chemical history of this group from the errors of his predecessors, I yet found that much remained to be done, especially as the Californian ore differs from the Siberian in the greater relative proportion of Ruthenium which it contains. This difference alone renders a different treatment of the ores necessary. In the course of the investigation which I have undertaken, I have been able to test upon considerable quantities of material, nearly all the methods of working the ores of osmium, etc., which have hitherto been employed. As the experience thus obtained has been at great expense of time and labor I will here give it as concisely as possible, believing that it will be useful to others, who may hereafter take up the same subject.

States Assay Office, the proportion of osmiridium in the California gold, did not exceed half an ounce to the million of dollars. Afterward, the proportion rapidly increased till the average was seven or eight ounces to the million of gold. Then for a year or more the quantity diminished, but for the last year it has been as large as ever. These differences depend upon the variable composition of the native gold, and the constant discovery of new diggings.

The grains of osmiridium, suitable for pens, are roundish and solid, not liable to exfoliate when struck or heated. They seem to have a different composition from the compressed and tabular crystals. The proportion of them is usually not more than a tenth of all the alloy, but it is sometimes as large as one-fifth.

The carefully selected grains used by the gold pen makers are so minute that from 10,000 to 15,000 of them are contained in a single ounce. The very best are worth at least $250 an ounce, and a cubic inch, which would be equal to about eleven ounces, is worth $2,750.

Fremy's* most recent method consists in roasting the ore in a current of air or oxygen at a strong red heat. Under these circumstances the osmium is in a great measure removed as osmic acid, while the other metals are more or less completely oxydized. The mass from which the osmium has been removed is then to be fused with nitre, after which the remaining osmium may be separated by distillation with nitric acid. Fremy gives a method for the separation of the other metals from each other, which however cannot yield these in a state of purity. The separation of the osmium by roasting, has undoubtedly the advantage of giving pure osmic acid in large quantity and at small expense of materials. On the other hand, this process is not applicable to all the varieties of osmiridium, while in those to which it does apply the roasting does not remove all the osmium, and consequently does not obviate the necessity of one or more subsequent fusions with powerful oxydizing agents. So far as the iridium, rhodium and ruthenium are concerned, it is better to oxydize at once as Claus recommends, by fusion with nitre and caustic potash. In an experiment which I made to test Fremy's process and in which I employed California ore in the form of fine gray sand and heated to full whiteness in a porcelain tube, I obtained after long heating but little osmic acid; the tube became clogged and broke, and after cooling I found that the ore had actually melted and presented a gray mass, having the shape of the tube in which it was fused. This mass resembled when broken a fine grained cast iron; it was very hard and distinctly crystalline upon those parts of the fracture nearest the surface. As the large scales of osmiridium from California do not melt before the flame of the compound blowpipe this result was very unexpected; it was doubtless owing to the large quantity of iron which the ore contained.

In a memoir published in 1835, Persoz† gave a method of working osmiridium by first converting the metals into sulphids. The ore is to be mixed with carbonate of soda and sulphur and then projected into a strongly heated earthen crucible. The crucible is then to be heated to whiteness, allowed to cool and broken. According to Persoz, the contents of the crucible consist of three layers, of which the lowest contains nearly all the sulphids of the platinum metals. The two lower layers are to be treated with water to dissolve the alkaline sulphids, and the remaining mass heated with oxyd of mercury which leaves oxyd of iridium—according to Persoz—while oxyd of osmium and metallic mercury are expelled.

* Comptes Rendus, xxxviii, 1008.

† Ann. de Chimie et de Physique, 55, 210.

Weiss and Doebereiner* confirmed the results of Persoz so far as the conversion of the platinum metals into sulphids was concerned. They recommended the fusion of the sulphids, after removing those of sodium and of iron by washing with water and chlorhydric acid, with carbonate of potash and saltpetre, so as to oxydize the sulphur and the platinum metals at the same time. By this process the ore is almost completely resolved in two operations.

On repeating these experiments with the California ore, I obtained the same results as to the formation of the metallic sulphids. After digesting the fused matter with chlorhydric acid and washing, there remained a greyish mass of crystalline scales, which resisted even boiling nitro-muriatic acid,—no smell of osmic acid being perceptible. These scales were however powerfully acted upon by fused caustic potash to which saltpetre was cautiously added, or by a mixture of carbonate and nitrate of potash, but the process could only be conducted on a small scale in consequence of excessive frothing which rendered it necessary to use very large vessels. Chlorine gas at a red heat exerted no sensible action upon the mixed sulphids.

The difficulties attending the fusion of the mixed sulphids with oxydizing agents may however be readily overcome by previously reducing them to the metallic state. This is most simply accomplished by a method suggested to me by Dr. Genth, which consists in evaporating the sulphids to dryness with a small excess of strong sulphuric acid and then igniting gently. A gray metallic sponge remains, which contains all the platinum metals with a small quantity of iron. It is easily reduced to a fine powder by rubbing in a mortar and may then be completely oxydized by Claus' method presently to be described. Nitro-muriatic acid acts very slightly upon this metallic mixture and I have not found it possible by this agent to remove an appreciable trace of platinum.

This process when carefully conducted gives good results but is not free from inconvenience. In the first place the treatment of the mixed sulphids with sulphuric acid must frequently be repeated twice in order to ensure the complete conversion of the sulphids into metals. Again the action of a mixture of caustic potash and saltpetre at a high temperature upon the finely divided metallic mass is violent and not free from danger when all the materials are heated together. The danger may be avoided by fusing the nitre and potash together and, after all frothing has ceased, projecting the metallic sponge little by little into the crucible, waiting in each case until the resulting action has ceased before projecting a fresh portion. I am of opinion that the pre-

* Annalen der Pharmacie, xiv, 15.

vious conversion of the platinum-metals into sulphids and subsequent reduction to the metallic state is upon the whole more inconvenient and requires more time than the direct resolution of the ore by fusion with an oxydizing mixture.

Experiments which I have instituted upon the effects of fusing the ore with steel, phosphorus, arsenic and sodium, led to no really valuable practical results. It is true that an alloy with steel can be obtained by fusion at a high temperature. Acids slowly dissolve the iron in this alloy and leave the platinum metals in the form of a black powder which is attacked by nitro-muriatic acid, though not completely dissolved. But the process is tedious and the results not very satisfactory.*

Wöhler's† method of resolving osmiridium, consists in passing moist chlorine over the ore mixed with common salt and heated to low redness in a glass or porcelain tube. This method is invaluable in analysis and gives excellent results in working the ore upon a small scale. In all cases however, several repetitions of the process are necessary for complete resolution or reduction to a soluble form. On the other hand, it can scarcely be doubted that this method could be advantageously employed upon the large scale, if vessels of porcelain of large size and of a proper shape could be obtained. Such vessels might be constructed in the form of long and flattened ellipsoids, furnished at each extremity with wide tubes several inches in length, and would be of great utility in various chemical processes. No process of fusion with oxydizing agents compares with Wöhler's method in point of elegance, as no iron or other impurities afterward to be removed, are introduced by the process itself.

Fritzsche and Struve‡ treat the ore with a mixture of equal parts of hydrate and chlorate of potash, by which a more or less complete oxydation is effected, without any sensible evolution of osmic acid. The temperature required in this process is not high, but large vessels must be employed as the mixture froths very much at first. The process in question has not appeared to me to possess any sensible advantage over that of Claus, which is moreover less expensive and can be carried out with smaller vessels.

Claus'§ method of resolving the ore consists in fusing for an hour, at a red heat, a mixture of one part of ore with one part

* Since the above was written the elaborate memoir of Deville and Debray on the platinum metals has appeared. (Ann. de Chimie et de Physique, 3d, lvi, 385.) I have not however been able to repeat any of the processes for subdividing or oxydizing osmiridium given by these chemists but consider it probable that the subdivision of the ore accomplished by fusion with zinc may be simpler than that which I have described above.

† Pogg. Annalen, xxxi, 161.

‡ Journal für prakt. Chemie, xxxvii, p. 483.

§ Beiträge zur Chemie der Platin-metalle. Dorpat, 1854.

of caustic potash and two of saltpetre. The fused mass is to be poured out upon a stone, allowed to cool, broken into small pieces or powdered, and then introduced into a flask which is to be filled with cold water and allowed to stand for twenty-four hours. The clear deep orange red solution of osmate and ruthenate of potash is then to be drawn off by means of a syphon, and the black mass remaining again washed in the same manner. The finely divided oxydized portion of the insoluble matter may now be separated from the unattacked ore by diffusion in water and pouring off, after the subsidence of the heavier ore. The unattacked ore is then to be fused a second time with potash and saltpetre and treated as before. Claus asserts that he has been able in this manner to resolve the Siberian osmiridium completely in two operations.

I have not always been so fortunate with the raw California ore, even when in a finely divided state. On the contrary, after three or four successive fusions there usually remained a large quantity of black matter insoluble in aqua regia. In one operation with 500 grammes of ore only 200 grammes were rendered soluble by two fusions with potash and saltpetre. I employ at present the method of Claus with several modifications which I deem essential. The ore, which is usually very impure, is in the first place to be fused with three times its weight of dry carbonate of soda. The fused mass after cooling is to be treated with hot water to remove all the soluble portions and then the lighter portions are to be separated by washing from the heavy unattacked ore. In this manner the greater part of the silica and other impurities present may be removed. A previous purification of this kind is not indispensable and may be omitted altogether when the ore is in plates or large grains, but it is very desirable when the ore is fine powder and greatly facilitates the subsequent action of the oxydizing mixture. Claus recommends the purification of the ore by boiling with a solution of caustic potash. It is certain that a much larger portion of the ore is resolved by two successive fusions with potash and nitre after previous purification by fusion with soda and washing. By cutting off the top of a mercury bottle a wrought iron crucible is obtained in which 600 grammes of osmiridium may be fused at one operation with potash and saltpetre as above. There is usually little or no foaming and if any occur it may easily be checked by stirring with an iron rod. No sensible quantity of osmic acid is given off during the process, which with a little care is entirely free from danger. In this manner, I have worked up 1500 grammes of ore in a few hours in three successive operations.

Claus' method of treating the fused mass to separate ruthenium and osmium is liable to two sources of inconvenience. In

the first place, the quantity of water required to dissolve out the soluble portions is very large, and the subsequent treatment of such bulky solutions by distillation with acids, tedious—very large retorts being necessary. In the next place, it is impossible in this way to avoid exposure to the vapor of osmic acid, especially in transferring the solutions from one vessel to another. I therefore prefer the following process which leaves nothing to be desired in point of safety or convenience. The fused mass is to be broken into pieces with a hammer and brought into a clean iron pot—a common skillet with a long handle answers this purpose extremely well. Boiling water containing about one-tenth of its volume of strong alcohol is then to be added and the whole is to be boiled over an open fire until the fused mass is completely disintegrated. The osmate of potash is in this manner reduced to osmite $KOsO_4$, while the ruthenate of potash is completely decomposed, the ruthenium being precipitated as a black powder—probably a mixture of RuO_2 and Ru_2O_3 or of the hydrates of these oxyds. It is advantageous, after boiling for some time, to pour off the supernatant liquid with the lighter portions of the oxyds and boil a second time with a fresh mixture of alcohol and water. In this manner we obtain a solution of osmite of potash, a large quantity of black oxyds and a heavy black and coarse powder. This last consists chiefly of undecomposed ore mixed with a small quantity of the oxyds of iridium &c., with scales of oxyd of iron from the crucible and, if the ore has not been previously purified, with the impurities of the ore itself. The greater specific gravity of this residual mass renders it very easy to pour off from it the mixture of black oxyds with the solution of osmite of potash and alkaline salts. This solution with the suspended powder is to be poured into a beaker and allowed to settle. The heavy black powder remaining in the iron pot is then to be perfectly dried over the fire and fused a second time with potash and saltpetre as before. The fused mass is to be treated exactly as after the first fusion. The heavy portions remaining after this operation may be fused a third time with the oxydizing mixture. When however the ore has been previously purified by fusion with carbonate of soda, or when it was originally in the form of clean scales, the heavy portion remaining after two successive oxydations will be found to consist chiefly of scales of oxyd of iron.

The solutions containing osmite of potash and alkaline salts are to be carefully drawn off by a siphon from the black oxyds which have settled to the bottom of the containing vessels. The oxyds may then be washed with hot water containing a little alcohol and introduced into a capacious retort. By this process, when carefully executed, no trace of osmic acid escapes—an advantage not to be despised, as the deleterious effects of this body

upon the lungs have not been exaggerated and too much care cannot be taken to avoid inhaling it.

The solution of alkaline salts contains only a portion of the osmium in the ore. The other portion exists in the mixture of oxyd and must be separated by distillation. For this purpose the retort should be provided with a safety tube passing through the tubulure and with a receiver kept cold, and connected by a wide bent tube with a series of two or three two-necked bottles containing a strong solution of caustic potash with a little alcohol and also kept cold. All the tubulures and connections must be made perfectly tight. Strong chlorhydric acid is then to be cautiously poured into the retort through the safety-tube in small portions at a time. The reaction which ensues is often violent; great heat is evolved and a portion of the osmic acid distils over immediately and condenses in the receiver in the form of colorless needles. When a large excess of acid has been added, the action has entirely ceased and the retort has become cold, heat may be applied by means of a sand bath. The osmic acid gradually distils over and condenses in the receiver and in the two-necked bottles. Especial care must be taken that the beak of the retort is not too small at the extremity as it may otherwise become completely stopped up with the condensed osmic acid. The same applies to the tubes connecting the receivers and two-necked bottles. The distillation should be continued for some time after osmic acid ceases to appear in the neck of the retort; when this has once become hot the acid condenses and passes into the receiver in the form of oily drops.

When the distillation is finished the retort is to be allowed to cool and then separated from the receiver which is to be immediately closed with a cork. By gently heating the receiver in a water-bath the contained osmic acid may be driven over into the two-necked bottles where it condenses in the alkaline solution and is reduced by the alcohol to osmite of potash. The solution thus obtained may be added to that obtained directly from the fused mass of ore and on evaporation in a water-bath and cooling will yield crystals of osmite of potash, the salt being but slightly soluble in strong saline solutions. The mother liquor from the crystals contains only traces of osmium and may be thrown away as worthless.

The dissolved portions drawn off from the retort have a very dark brown-red color. The solution is to be evaporated to dryness, redissolved in hot water and again evaporated, after adding a little chlorhydric acid, and this process repeated till no smell of osmic acid can be perceived. A cold and saturated solution of chlorid of potassium is then to be added in large excess. This dissolves the chlorids of iron and palladium which may be present, leaving platinum, iridium, rhodium and ruthenium as double chlorids insoluble in a strong solution of the alkaline chlorid.

The undissolved mass is to be well washed with a saturated solution of chlorid of potassium which, for reasons hereafter to be mentioned, is preferable to salammoniac. In this manner nearly the whole of the iron and palladium may be removed, while any insoluble impurities contained in the ore remain with the mixed double chlorids.

New York, Oct. 31st, 1860.

(*To be continued.*)

ART. VIII.—*On a Method of Producing Stereographs by Hand;* by OGDEN N. ROOD, Prof. of Chemistry in Troy University.

[With a Stereoscopic diagram.]

SIR DAVID BREWSTER in his *Treatise on the Stereoscope*, (London, 1856) page 135, after describing a method of projecting the picture seen by one eye, of a symmetrical, geometric solid, and of obtaining by reflexion from a mirror a drawing of its stereoscopic companion, states: "When the geometrical solids are not symmetrical, their dissimilar pictures must be taken photographically, from models, in the same manner as the dissimilar pictures of other solids."

Upon page 200 of the same work he states, that though apparatus may be photographed *directly*, yet that stereoscopic diagrams, can only be executed by the use of models made of *wire*, which are to be photographed in the usual way.

The same author in the article Stereoscope, *Encylopædia Britannica*, vol. xx, 1859, p. 690, writes: "As no artist, however skillful, is capable of executing two pictures of any individual object, or group of objects, as they are seen by each eye separately, the stereoscope was of little value before the art of photography enabled us to take such pictures with the most perfect accuracy."

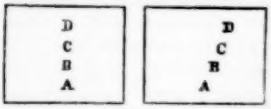
In addition to these statements, which would seem to imply the impossibility of producing stereographs by hand, I have not been able to learn from scientific friends nor from professional photographers, that any process is now in use to effect this end, except the laborious and imperfect one of geometrical *projection*. Under these circumstances, I venture to describe a simple method of drawing stereographs, which possibly may supply a want in this department.

When we examine attentively a photographic stereograph with the aid of micrometrical measurements, and adopt the left-hand picture as a *standard of comparison*, we find that the right-hand picture is an exact reproduction of it, with one important exception; viz., that in the right-hand picture the position of an object, a little more distant from the spectator than the immediate foreground, is *shifted* a small distance toward the right

hand; objects farther back, have their position shifted still more to the right hand, &c.

This is illustrated by fig. 1, where A is in the immediate foreground, and D in the background.

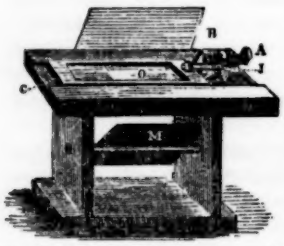
1.



Now if we had a single drawing in perspective, of a house for example, and could produce a fac-simile of it, this would evidently answer for the left-hand picture. If we could again reproduce this drawing on the right hand of the slide, with all the objects or points in it back of the immediate foreground, *shifted* to the right hand the proper distances, we should have a pair of pictures, which when combined in the stereoscope would give relief.

To accomplish this is the object of the machine seen in fig. 2.

2.



It consists of a board, 10 in. by 14, having a square opening O, in its centre 5 inches wide; this is covered by a plate of glass which is let into the wood and lies even with its upper surface. The slider C is moveable in the direction indicated in the figure: its motion is effected by the screw A, which acts against the India rubber band I: the screw and its support are removable at pleasure. The mirror M serves for illumination; the shade B moves on hinges, and regulates the amount of light which falls on the paper while the drawing is being made.

To produce a stereograph, the object or objects to be represented are drawn in perspective with ink on writing paper; this is oiled to render it transparent, the excess of oil is removed, and the drawing is attached with a drop or two of gum arabic to the glass plate, which is completely exposed by the removal of the slider. The under side of the latter is covered with ordinary writing paper or with thin paper, and it is slid into the machine till the drawing is seen under its left half, the screw having been previously removed. In this position it is fastened securely by a screw at C, and the drawing is traced slowly, line by line, until as perfect a fac-simile as can be made by hand has been produced; this is the left-hand picture.

The slider is now moved toward the right hand a distance of 2·6 in. and the screw with the India rubber band attached.

An object, or a small portion of an object, in the *immediate foreground* is now traced, then the screw is turned slightly so as throw the next object, or the remainder of the first object, slightly toward the right hand where it also is drawn, &c. Thus we advance slowly toward the background, turning the screw

each time that depth is to be represented. This in practice is a very simple operation, and if the displacements toward the right hand have been rightly proportioned the effect produced is good.*

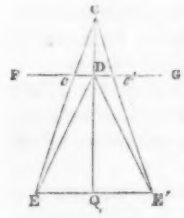
The process is also a rapid one, for it consists only in making two tracings.

The question now arises as to the total amount of displacement allowable, and as to its proper distribution.

If a number of stereoscopic photographs are examined it will be found that in those where the sum of all the displacements is not more than one or two tenths of an inch the two images are readily united, and a good general effect produced, while in those where this quantity is as great as three or four tenths, difficulty is experienced in effecting the union.

Taking then ·2 of an inch as the maximum total displacement allowable, the method of its distribution from foreground to background can be calculated in the following way:

3.



Let EE′ be the distance between the eyes =2·5 in., QD=6 in. the nearest distance of distinct vision; CD=1 in. A small object being placed at D and another at C, the eye E sees the two objects projected in the line FG at c and D; the eye E′ sees the same objects at D and c'. Here the total displacement, adopting the picture seen by the left eye as a standard of comparison, is equal to the distance cc'. With the proportion:—

$$QC : EQ = (1{\cdot}25 \text{ in.}) :: CD : cD = \frac{cc'}{2}$$

we have at once the value of this quantity. In like manner this displacement on the line FG for 2, 3, 4 or any number of inches from Q is readily calculated.

As an example I subjoin the following table applicable to small models:

For the 19th inch above 6 inches,

		Total displacement.		
or for the 25th inch,	. .	1·900 inch,	=	0
26	" . . .	1·922 "	"	·022
27	" . .	1·940 "	"	·040
28	" . . .	1·960 "	"	·060
29	" . .	1·980 "	"	·080
30	" . . .	2·000 "	"	·100
31	" . .	2·016 "	"	·116
32	" . . .	2·030 "	"	·133
33	" . .	2·045 "	"	·145
34	" . . .	2·058 "	"	·158
35	" . .	2·072 "	"	·172
36	" . . .	2·082 "	"	·182

* It will sometimes happen that portions of objects in the background which were hidden in the left picture are brought into view in the right hand representation. This offers no practical difficulty, for the indicated additions are readily made.

As in using this table objects in the extreme foreground are supposed to be 25 inches distant from Q, we have for them not a displacement 1·900 in. but 0: for the 26th inch, viz. the 1st inch of depth in the picture the quantity ·022, &c. Thus if we know the distance from the spectators of the objects to be represented, they can be located on the stereograph. In the same manner tables are constructed which apply to objects placed at greater distances from the eye. Indeed after some practice very tolerable stereoscopic representations of many objects can be made without reference to such tables. (See drawing.)

This process was originally devised by me for the production of stereoscopic representations of optical phenomena, which when well executed form almost a substitute for the real illustrations. Photography for obvious reasons is not well adapted to this class of objects.

By coloring *differently*, corresponding parts of two stereoscopic pictures, or by the application of color to only one, the other being allowed to remain white or black, or by completing certain parts of the drawing only in one picture, many appearances connected with subjective optical phenomena can be represented with a degree of perfection unattainable in a single picture.

Prof. H. W. Dove, (*Farbenlehre*, p. 166) has studied the effects produced by coloring two stereoscopic drawings differently, though I am not aware that he has made this application of the results he obtained.

By slightly rotating the instrument around a line perpendicular to its axis, as was remarked to me by Prof. B. Silliman, Jr., many of these effects are greatly enhanced. The phenomena of complementary colors, and many other facts of physical optics not otherwise within the reach of most students, may also, as the same gentleman has suggested to me, be rendered intelligible by the stereoscope without the use of costly apparatus. The stereoscope is thus capable, in the hands of an expert teacher, of a far wider range of use than was at first seen.

At the suggestion of Dr. W. Gibbs, I have also made a few stereoscopic drawings of crystal models: these can be drawn by this instrument with perhaps greater facility and rapidity than any other class of objects.

The accompanying stereoscopic diagram was drawn with my apparatus without reference to tables.

Outline sketches of every description, stereoscopic drawings of ideal objects or of objects not in the possession of the draftsman, are by this process readily executed—problems evidently beyond the power of photography.

Finally the drawings thus made can be transferred to wood and stone and reproduced by the thousand.

Troy, Oct. 11th, 1860.

ART. IX.—*Note on Sources of Error in the Employment of Picric Acid to detect the Presence of Potash;* by M. CAREY LEA, Philadelphia.

[Read before the Am. Assoc. for the Adv. of Sci., at Newport, August, 1860.]

PICRIC acid enjoys a high reputation as a test for potash. Employed in its alcoholic solution, or as soda or ammonia salt sometimes as magnesia salt, it gives with potash solutions a dense yellow crystalline precipitate. If the solution containing potash be very dilute, the precipitate may not make its appearance till after some hours repose, and it then forms long delicate needles.

Rose remarks that this reagent "is even more sensitive than the solution of chlorid of platinum." In his summing up, he observes, that of the various reagents, chlorid of platinum, tartaric acid, picric acid, perchloric acid, sulphate of alumina and hydrofluosilicic acid, the latter is insufficient to distinguish between potash and soda; and that the chlorid of platinum and sulphate of alumina give the same reactions with ammonia as with potash.* No qualification is made with respect to the certainty of the indications afforded by picric acid. Plattner makes the same observation as to the greater sensitiveness of picric acid compared with bichlorid of platinum and equally without qualification as to its reliability.†

I therefore believe that the remarkable insolubility of otherwise soluble alcaline picrates, in alcaline solutions has not been before pointed out. If an alcoholic solution of picric acid be poured into a solution of carbonate of soda, it occasions an immediate dense yellow precipitate, not to be distinguished in appearance from a precipitate of picrate of potash, and liable to be mistaken for it with the greatest facility. The picrate of soda formed in the case just mentioned is the most soluble of all the alcaline picrates, and *à priori* we should not expect to find it precipitated under these circumstances: an aqueous solution of picrate of soda added to one of carbonate of soda acts in precisely the same manner.

To ascertain if these reactions were extended to various compounds of picric acid, examinations were made which gave with the following results:

Alcoholic solution of picric acid added to—

solution of carbonate of ammonia, gave an immediate dense yellow crystalline precipitate.

" carbonate of soda gave not so instantaneous a precipitate, but one which after standing became even more dense.

* Rose, Handbuch der Analytischen Chemie, 1r Band, 6-10 S.

† Plattner, die Probirkunst mit dem Lothrohre, 3d Ed. p. 178.

Aqueous solutions of picrate of soda gave with
solution of carbonate ammonia, } abundant precipitates.
sulphate of ammonia, }
carbonate of soda, }
phosphate of soda, slight precipitate.
Aqueous solution of picrate of ammonia gave with
solution of carbonate of ammonia, } abundant precipitates.
" sulphate of ammonia, }
" carbonate of soda, }
" phosphate of soda, none.
Aqueous solution of picrate of magnesia gave with
solution of carbonate of soda, } abundant precipitates.
" carbonate of ammonia, }

When the alcaline solutions to be tested are otherwise than very dilute there is absolutely no difference in the appearance of the precipitates. When the amount of precipitate is small, the following differences may be observed:

The potash precipitate forms longer needles, and when these are found only after standing, or when the precipitate is redissolved by heat and allowed to crystallize by slow cooling, they exhibit a beautiful play of red and green colors.

The soda salt is of a lighter and brighter yellow than either the potash or ammonia salt. Its needles are also shorter than those of either of the other compounds, and when the precipitate has been redissolved by heat, and allowed to crystallize by slow cooling, they tend to agglomerate themselves together in spherical masses. This is a very marked character, and when exhibited, is unmistakable, but is not always shown.

The ammonia salt when crystallized in quantities is very distinct in appearance from the potash salt, but when thrown down in small portions, even by slow crystallization, cannot be distinguished from it with certainty. The prisms are flatter, but these differences are not apparent in very slender needles. The play of colors which the ammonia salt exhibits to a less degree than the potash, disappears entirely in the soda salt.

The above reactions indicate that extreme caution must be used in employing picric acid as a test for potash. The precipitates above described do not redissolve in any excess of the picrate, or of picric acid; nor is it to be supposed that concentrated alcaline solutions are necessary to cause them—on the contrary, in many cases, very dilute ones are sufficient. To determine within what limits such reactions are produced, the following trials were made:

A. Dilution of the alcaline solutions. Limits obtained,

(I.) With carbonate of soda,

A solution containing 5 per cent anhydrous carbonate of soda gave
with alcoholic solution of picric acid, an immediate abundant precipitate, in 10 minutes the tube could be inverted without spilling the contents.
with solution picrate of soda, an immediate precipitate becoming in the course of an hour a very dense one.
A solution containing $2\frac{1}{2}$ per cent carbonate of soda gave
with alcoholic picric acid, a slight precipitate increasing very much by standing, so that after 18 hours the tube could be inverted without spilling the contents.
with picrate of soda, none.
A solution containing 1 per cent carbonate of soda gave
with alcoholic picric acid, slight precip. after 18 hours repose.
with picrate of soda, none.
(II.) With sulphate of ammonia,
A solution containing 5 per cent anhydrous sulphate ammonia gave
with alcoh. picric acid, immediate dense precip.
" picrate soda " " "
solution containing $2\frac{1}{2}$ p. c. sulph. ammonia gave
with alcoh. picric acid, immediate dense precip.
solution containing 1 p. c. sulph. ammonia gave
with alcoh. picric acid, immediate dense precip.
" solution picrate soda, immediate slight precipitate. The solution on standing gave a beautiful crystallization of long needles with bright play of colors, exactly resembling the reaction of potash salts.
" picrate magnesia, by long standing, a very faint precip.
" picrate ammonia, none.
solution containing $\frac{1}{250}$ anh. sulphate ammonia gave
with alcoh. picric acid, after a short interval an abundant precipitate.
solution containing $\frac{1}{500}$ anh. sulph. ammonia gave
with alcoh. picric acid, after a short interval, a considerable precip.
solution containing $\frac{1}{1000}$ anh. sulph. ammonia gave
with alcoh. picric acid, no precipitate, even after twenty-four hours' repose.

B. Limits obtained with respect to indications of diluted solutions of alcaline picrate.

A solution of picrate of ammonia in 200 parts water gave—with an equal volume of strong solution of carbonate of ammonia, an immediate precipitate of small yellow needles—in 10 minutes a considerable quantity settled at the bottom of the vessel.

A solution of same salt in 400 water gave with an equal volume of solution carbonate ammonia, signs of a precipitate in a few minutes, and after some hours an appreciable quantity settled at the bottom of the vessel.

With 1 part picrate ammonia in 800 water no precip. was produced by solution of carb. ammonia even after 24 hours' repose.

The conclusion to be drawn from these results is,

That alcoholic solution of picric acid or aqueous solution of picrate of soda will produce a precipitate in almost any alcaline

solution, whether of soda, ammonia or potash, except under circumstances of great dilution, especially if allowed to repose for 24 hours.

That picrate of ammonia and picrate of magnesia give the same results, but in a less degree.

That picric acid is therefore wholly unreliable as a test for potash; the results obtained being such as would tend altogether to mislead those who are not extremely familiar with the appearance of the precipitates, and that in some cases the results are so deceptive that even eyes most familiar with these reactions might be deceived; for example, in the result obtained above by testing a solution containing 1 per cent. sulphate of ammonia with solution of picrate of soda. In this case a crystallization of picrate of ammonia was obtained perfectly simulating that of the potash salt.

Picric acid is in fact a better test for soda, than for potash, because with a soda solution it gives a precipitate which redissolved by heat generally (but not always) gives a characteristic spherically radiated, bright canary yellow crystallization, whereas the precipitate obtained from a potash solution can never be positively distinguished by its appearance from that afforded by an ammonia solution, and we have just seen that a solution containing $_2{}^1{}_0$ of sulphate of ammonia or even less, is capable of producing such a precipitate.

Philadelphia, Feb. 23d, 1860.

ART. X.—*On a Series of New Combinations of Ammonia, Picric Acid and Metallic Bases;* by M. CAREY LEA.

[Read before the Am. Assoc. for the Advancement of Sci., at Newport, Aug. 1860.]

IN a paper published in this Journal, vol. xxvi, 379, for 1858, I described two compounds of picric acid and ammonia with copper and nickel respectively, and mentioned their instability and the great difficulty of obtaining them in a state of tolerable purity. Since then I have found that many other metals form compounds of a similar nature, and have succeeded in obtaining several of them sufficiently pure for approximate analysis. The results obtained are given below—other investigations are in progress and I hope to communicate them hereafter.

When a metallic salt is precipitated by ammonia, and a large excess of the precipitant added, a more or less complete solution of the precipitate is frequently obtained, especially if a considerable quantity of ammoniacal salt be present. I have found that these ammoniacal solutions when treated with an alcaline picrate, for the most part yield an immediate precipitate containing

the elements of a metallic picrate united with those of ammonia. These precipitates are often very beautiful, they are generally yellow or yellowish, somewhat soluble in the mother liquid, or in strong ammoniacal solutions by aid of heat, nearly insoluble in water and decomposed by it very readily, especially if it be present in quantity, or heat be applied. Thrown on a filter and washed, the picric acid, ammonia, and some portion of undecomposed salt in solution pass through, while the greater part of the metallic oxyd remains on the filter and with sufficient washing is perfectly freed from picric acid and ammonia, and presents the appearance of a pure hydrate.

The analyses of these substances were made in the following manner. It was found desirable that before the ammonia and metallic oxyd were determined, the whole of the picric acid should first be removed. This was effected by adding chlorhydric acid to a weighed quantity of the substance carefully dried, and evaporating to dryness at a gentle heat. Ether, which must be anhydrous or nearly so, was added in the proportion of 15 to 18 grammes to ·6 or ·7 gms. of the salt used, detaching the dry crust and breaking it up to powder with a glass rod that every part might be brought thoroughly in contact with the ether. After standing ten minutes the ether was poured off, a fresh quantity added, and a larger beaker was inverted over that which contained the substance undergoing analysis. After a lapse of three or four hours the liquid was poured off, a third, and, if necessary, a fourth, quantity added in the same way. The decantation is effected with the greatest ease, as, if the ether is sufficiently strong, the chlorids remain nearly or quite dry at the bottom. It was found that by this means the picric acid could be separated with sufficient exactness to afford a tolerably correct estimation of its quantity, a careful trial with a weighed quantity of perfectly pure picric acid showed that the result fell a little under the truth by reason of a small loss arising from minute portions of the acid remaining undissolved. On the other hand, no chlorids are dissolved when the operation is properly performed: the etherial solution evaporated to dryness, and the residue dissolved in water was not troubled by solution of nitrate of silver.

The operation requires nice manipulation, otherwise the loss of picric acid is considerable, and if the ether be not sufficiently anhydrous, portions of the chlorids may be removed by it.

In this manner the quantity of picric acid was determined, and from it was calculated the quantity of the group $C_{12}H_2N_3O_{14}$, or picric acid minus the equivalent of hydrogen which is replaceable by a metallic oxyd; in other words, the group which by union with a base forms a picrate, or by union with hydrogen forms picric acid. From the residue undissolved by the ether, the ammonia was determined either by distillation with solution of caustic soda, or by precipitation with bichlorid of platinum.

From another portion the metallic oxyd was found by appropriate means.

As far as examined, the ammonia-picrates all contain more than one equivalent of ammonia, and are represented either by the formula:—

$$2\widehat{NH_3}MO.C_{12}\begin{matrix}H_2\\3NO_4\end{matrix}\Big\}O \text{ or } 3\widehat{NH_3}2\left[MO.C_{12}\begin{matrix}H_2\\3NO_4\end{matrix}\Big\}O\right].$$

Ammonia-picrate of silver.

Nitrate of silver dissolved in water and treated first with excess of ammonia, and the resulting clear solution mixed with cold saturated solution of picrate of ammonia gives immediately an abundant highly crystalline light yellow precipitate of ammonia-picrate of silver, which is to be thrown upon a filter, thoroughly washed with dilute ammonia, and dried in vacuo over sulphuric acid.

It is to be observed that in the formation of this, as well as of all the other salts here described, the metallic solution must invariably be in excess to check as far as possible the precipitation of picrate of ammonia together with the compound sought. I have shown in a paper intended to be read at the same time as this,* that if an alkaline picrate be poured into an alkaline solution, a precipitate of alkaline picrate takes place. When the alcaline solution is strong the precipitate is immediate, and in the ammoniacal solutions used in the preparation of these salts any excess of alkaline picrate would fall with the ammonia-picrate. Even with every precaution, it is difficult and in some cases apparently impossible to obtain the ammonia-picrate perfectly free from this impurity.

Analysis.

·4245 substance gave ·2632 picric acid.
·5865 " " ·3600 " "
·4245 " " ·1577 chlorid of silver.
·5865 " " ·2177 " "
·3788 " " ·4932 chloroplatinate of ammonia.

This leads to the formula:—

$$2NH_3\widehat{AgO}C_{12}\begin{matrix}H_2\\3NO_4\end{matrix}\Big\}O.$$

Dried over sulphuric acid in vacuo:—

	Calculated.	Found. 1.	2.	Mean.
$C_{12}H_2N_3O_{14}$ - - -	61·62	61·73	61·11	61·42
Ag - - - - - -	29·19	27·96	27·94	27·95
$2NH_3$ - - - - - -	9·19	9·93		9·93
	100·00	99·62		99·30

* See page 75.

The silver falls below, and the ammonia exceeds the calculated amount in consequence of the impossibility of obtaining the salt quite free from admixed picrate of ammonia.

This beautiful salt appears to be one of the most permanent of this very unstable class of substances. It dissolves readily in hot water containing ammonia, sparingly in cold, and crystallizes in fine needles from the hot solution. Heated on platinum foil it detonates and leaves a brilliant spot of metallic silver.

Ammonia-picrate of copper.

A cold saturated solution of picrate of ammonia added to an ammoniacal solution of sulphate or nitrate of copper, immediately throws down an abundant precipitate which after washing with strong solution of carbonate of ammonia and afterward with dilute ammonia exhibits a beautiful pale greenish yellow color with a shade of red through it. It is in fine scales and much resembles the dust of the wings of butterflies.

Analysis gave for this salt a constitution similar to that of the silver salt.

·6059	gms.	substance	gave	·4652 picric acid.
·9310	"	"	"	·1279 oxyd of copper.
1·4240	"	"	"	·1577 metallic copper.
·6059	"	"	"	·2190 chlorhydrate of ammonia.

The copper was determined in the one case by precipitating the cupric solution while boiling with hyposulphite of soda, dissolving in aqua regia, evaporating to dryness, redissolving in dilute chlorhydric acid, and precipitating with distilled zinc and estimating as metallic copper—in the other by precipitating at 212° by caustic soda.

These results lead to the formula:—

$$2NH_3\widehat{CuO}.C_{12}\begin{matrix}H_2\\3NO_4\end{matrix}\Big\}O.$$

Dried over sulphuric acid in vacuo:—

	Calculated.	Found. 1.	2.	Mean.
$C_{12}H_2N_3O_{14}$	77·63	76·44		76·44
Cu	10·79	10·97	11·07	11·02
$2NH_3$	11·58	11·52		11·52
	100·00			98·98

In an experiment to ascertain whether all the moisture was removed by drying in vacuo over SO_3, a quantity of about two grammes by exposure to a temperature of 210° to 212° for 9 hours in the exsiccator lost a little less than one and a half milligrammes.

Heated on platinum foil the ammonia picrate of copper explodes with some violence and with a dazzling light.

Ammonia-picrate of Cobalt.

To a solution of protochlorid of cobalt prepared from chlorid of purpureo-cobalt in the manner recommended by Gibbs and Genth in their interesting and valuable paper on the ammonia-cobalt bases, a large excess of ammonia was added, and to the filtrate, cold saturated solution of picrate of ammonia. An abundant highly crystalline precipitate falls at once, which after drying is yellowish green: while moist decomposes with great facility with separation of cobaltous oxyd.

·6293 substance gave ·4784 picric acid.
·6075 " " ·4594 " "
·6067 " " ·1641 protosulphate of cobalt.
·5416 " " ·1475 " " "
·6075 " " ·2065 chlorhydrate of ammonia.

which results lead to the formula:—

$$2NH_3\overset{\frown}{CoO}.C_{12}\begin{matrix}H_2\\3NO_4\end{matrix}\Big\}O+HO.$$

	Calculated.	Found. 1.	2.	Mean.
$C_{12}H_2N_3O_{14}$	75·87	75·69	75·29	75·49
Co	9·82	10·13	10·29	10·21
$2NH_3$	11·32	10·81		10·81
HO	2·99			
	100·00			

This salt is much more unstable than the foregoing, and undergoes a commencement of decomposition in washing: even when this part of the operation is performed with great care, using carbonate of ammonia and dilute liquid ammonia, a portion of picrate of ammonia is washed through, and as cobaltous oxyd is not easily soluble in ammoniacal solutions, it is not easily removed by washing with such. It is also probable that more or less cobaltous oxyd is thrown down with the precipitate, as the latter at the first moment crystalline, becomes quickly more and more curdy—and ammoniacal solution of cobalt by mere dilution with water throws down a bright green precipitate. In the preparation of the ammoniacal solution, it is better to drop a strong solution of cobaltous chlorid into a large excess of ammonia.

Like the foregoing this salt explodes by heat.

Ammonia-picrate of Zinc.

To a solution of pure sulphate of zinc, chlorhydric acid was added in sufficient quantity to prevent precipitation by the sub-

sequent addition of ammonia in excess. To the clear solution, a hot, strong solution of picrate of ammonia was added. Immediately the whole became nearly solid with beautiful yellow needles and scales—the beaker was rapidly cooled by cold water, the contents thrown on a filter, and washed first with a solution of carbonate of ammonia mixed with caustic ammonia, and finally with dilute caustic ammonia alone.

The splendid gold yellow mass of interlaced needles and scales, was more or less decomposed, even by the most careful washing, so that the brightest and purest parts only could be taken for analysis, nor were even these satisfactory.

$C_{12}H_2N_3O_{14}$	mean of 5	determinations,	81·26
NH_3	" 3	"	9·06
Zn			10·08
			100·30

The formula $3NH_3\frown 2\left[ZnO.C_{12}\begin{matrix}H_2\\3NO_4\end{matrix}\right\}O.\Big]$ requires:—

$2C_{12}H_2N_3O_{14}$	79·692
$3NH_3$	8·913
$2Zn$	11·395
	100·00

The salt examined may be either this compound containing admixed picrate of ammonia, or may be a mixture of:—

$$2NH_3\frown ZnO.C_{12}\begin{matrix}H_2\\3NO_4\end{matrix}\Big\}O, \text{ with}$$

$$NH_3\frown ZnO.C_{12}\begin{matrix}H_2\\3NO_4\end{matrix}\Big\}O.$$

The fact that when a strongly acid solution of zinc-chlorid is supersaturated with ammonia, the compounds $2NH_3$ ZnO HCl and NH_3 ZnO HCl successively crystallize out, speaks in favor of the latter hypothesis.

Ammonia-picrate of Cadmium.

The cadmium salt is obtained and purified in exactly the same manner as the zinc, which it nearly resembles: it is however not so bright in color, but pure canary yellow. Like the zinc salt it redissolves in its mother liquid by heat without decomposition, but like almost all the compounds here described, when washed with pure water on a filter, the picric acid and ammonia wash through. A greyish white residue of oxyd of cadmium remains behind.

Heated on platinum foil, the salt deflagrates with a beautiful green light.

·7170 substance gave ·5247 picric acid.
·6622 " " ·4877 " "
1·1459 " " ·8452 " "
·6496 " " ·1653 sal ammoniac.
1·1459 " " ·2945 " "
·6045 " " ·6289 chlorplatinate of ammonia.
·7321 " " ·1501 cadmium oxyd.

These results lead to the formula:—

$$3NH_3\overset{\frown}{2}\left[CdO.C_{12}\begin{matrix}H_2\\3NO_4\end{matrix}\right\}O.\Big]$$

	Calculated.	Found. 1.	2.	3.	Mean.
$2(C_{12}H_2N_3O_{14})$	73·67	73·44	72·86	73·31	73·20
$3NH_3$	8·24	8·10	8·17	7·93	8·07
2Cd	18·09	17·94			17·94
	100·00				99·24

It seems however not improbable that this substance may be a mixture in nearly equivalent quantities of the salts:—

$$NH_3\overset{\frown}{C}dO.C_{12}\begin{matrix}H_2\\3NO_4\end{matrix}\Big\}O \text{ and } 2NH_3\overset{\frown}{C}dO.C_{12}\begin{matrix}H_2\\3NO_4\end{matrix}\Big\}O.$$

for reasons similar to those mentioned in the case of the zinc salt.

Ammonia-picrate of Chromium.

This salt is easily obtained from an ammoniacal solution of chromoxyd which may be prepared in the following manner:

Three grammes of potash chrome alum are dissolved in water by boiling, the solution removed from the fire and 14 c. c. of pure concentrated sulphuric acid and 90 c. c. of liquid ammonia added. A strongly alkaline beautiful purple solution is thus obtained which may be preserved in well stopped vessels quite filled, for a considerable time.*

To a solution prepared in this manner, a strong hot solution of picrate of ammonia, not in excess, is to be added. Some precipitation follows at once which increases very much as the solution cools. The precipitate is thrown on a filter and washed with dilute liquid ammonia. It consists of splendid green metallic looking scales which if heated with a considerable quantity of water, even strongly ammoniacal, are decomposed with

* While studying the chromium salt, I met with Frémy's "Investigation of the salts of chromium." In it the author states that the salts of chromoxyd modified by boiling (green modification) are insoluble in ammonia except after having been boiled in acid and precipitated by ammonia. It will be observed that the above process is not in conformity with the opinion of M. Frémy, as it is there shown that the green modification, produced by boiling, is rendered soluble in ammonia *by the simple addition of sulphuric acid* and without any application of heat. The solution in ammonia is always complete, and the process never fails.

precipitation of chromoxyd. On cooling, picrate of ammonia crystallizes out. Even with very careful washing the salt is always partly decomposed, with separation of green oxyd of chromium.

The portions that were least decomposed were selected, but were not sufficiently pure to give any satisfactory result, although a number of specimens were analyzed.

1.	·6949	substance gave	·5864	picric acid.	
2.	·5537	"	" ·4735	"	"
3.	·4446	"	" .3709	"	"
4.	·4446	"	" ·0179	sesq. ox.	chromium.
5.	·6949	"	" ·0271	"	"

These numbers correspond to

1.	$C_{12}H_2N_3O_{14}$	84·02 per cent.
2.	"	85·14 " "
3.	"	83·06 " "
4.	Cr	2·78 " "
5.	"	2·63 " "

results which do not lead to any satisfactory conclusion, but show that the quantity of ammonia salt necessary to keep the chromoxyd in solution, throws down picrate of ammonia simultaneously with the ammonia-picrate of chromium. This salt is very beautiful, its lustre is remarkable.

Ammonia-picrate of Manganese.

If ammonia be added to a solution of manganous sulphate, previously rendered strongly acid with chlorhydric or nitric acid, a considerable quantity of manganese escapes precipitation, an extremely unstable solution is obtained, which in a few minutes, even before filtration is ended, becomes cloudy again. To give the solution more stability, the presence of a very large quantity of ammonia salt is necessary, a circumstance very unfavorable for the production of a pure ammonia-picrate, as by a solution so strongly saline, picrate of ammonia (as already observed) is at once precipitated. The following were the observations made:—

A. If a cold solution of picrate of ammonia be poured into an ammoniacal solution of manganese prepared by adding to a concentrated solution of manganous sulphate an equal volume of dilute chlorhydric acid, and then ammonia in large excess, there falls a precipitate of brilliant satiny scales, mixed however with precipitated manganous oxyd, which is readily distinguishable on the filter.

B. If the ammoniacal solution is added to a hot moderately strong solution of picrate of ammonia and the whole be rapidly

filtered, the liquid passes through before complete precipitation takes place, and on cooling, granular crystals are obtained which rapidly turn brown in the air. Heated on platinum foil, they turn brown, melt and deflagrate sharply with a brilliant white light.

Neither A, nor B, yield a salt sufficiently pure for analysis. A, always contains admixed manganous oxyd and B, picrate of ammonia. A, bears considerable resemblance to the chrome salt just described.

1·0115 of B gave ·9115 picric acid.

So large a percentage of picric acid corresponding to 89·72 per cent of the molecule $C_{12}H_2N_3O_{14}$ probably indicates a large admixture of picrate of ammonia, which cannot be removed. The formula

$$NH_3\overset{\frown}{MnO}.C_{12}\left.\begin{matrix}H_2\\3NO_4\end{matrix}\right\}O \text{ requires } 84{\cdot}59 \text{ per cent.}$$

Ammonia-picrate of Iron.

An ammonia-picrate of protoxyd of iron appears to exist. If solution of protosulphate of iron be mixed with one of salammoniac, and then with liquid ammonia, be rapidly filtered, and the filtrate be treated with picrate of ammonia, a dark green crystalline precipitate is obtained: thrown upon a filter a red liquid passes through containing a portion of the picrate of ammonia reduced by the ferrous oxyd. The precipitate, when heated on platinum foil, deflagrates with scintillations. Heated with solution of salammoniac and caustic ammonia, it does not appear to dissolve, but ferric oxyd is thrown down and picrate and picramate of ammonia remain in solution. It was found impossible to obtain this salt in a condition to admit of even an approximate determination of its constitution.

If acetate of lead be treated with ammonia in excess, and if to the clear solution be added picrate of ammonia, a curdy precipitate, at first pale yellow, gradually deepening to orange color falls. Heated on platinum foil it detonates with violence. Boiled with caustic alkali, it disengages no ammonia. The result of an analysis showed it to be Marchand's penta-basic picrate of lead, $4PbO\,PbO\,C_{12}\left.\begin{matrix}H_2\\3NO_4\end{matrix}\right\}O$. The above described salts containing ammonia are all highly crystalline. The lead compound just mentioned is amorphous.

Other ammonia picrates exist which I propose to examine hereafter.

Philadelphia, July 14, 1860

ART. XI.—*The Guernsey County (Ohio) Meteorites,—a complete account of the phenomena attending their fall with a chemical analysis of them;* by J. LAWRENCE SMITH, M.D., Prof. of Chemistry in the University of Louisville, Ky.

AGREEABLY to the promise made in the July number of this Journal, I propose giving, as far as possible, a complete account of the remarkable fall of meteoric stones that occurred in the month of May in the eastern part of the State of Ohio.

I have thought proper to call them the *Guernsey County Meteorites;* since we are commonly in the habit of distinguishing the meteorites found in this country, by the name of the county in which they fell or were found. All but one of the great number of meteoric stones that fell on this occasion, were found in Guernsey county and that exceptional specimen fell in Muskingum on the edge of Guernsey county.

Although the public have been notified of this phenomenon by various observers, especially by those who gave their observations in the July number of this Journal; yet, as this paper was nearly completed at the time, and is believed to embrace a full description, it is as well to present it to the public as it is; combining all the particulars of this fall of meteorites, the most remarkable ever observed in this country, and equal to, if not surpassing the famous fall at l'Aigle in France, with which it has many points of interest in common, that will be stated in the course of this paper.

My attention was first directed to this occurrence, by a short notice of it in a newspaper, as being an earthquake that had occurred in eastern Ohio, accompanied with a shower of stones Suspecting the true nature of the phenomenon, I immediately visited the spot, where it was said to have occurred and collected the statements of those persons who had witnessed the fall. It was ascertained that on Tuesday, May 1st, 1860, remarkable phenomena transpired in the heavens, of which the following are accounts given by different observers, men of intelligence and observation.

Mr. McClenahan states that at Cambridge in Guernsey county Ohio, (lat. 40° 4′ long. 81° 35′) about twenty minutes before one o'clock, P. M., three or four distinct explosions were heard, like the firing of heavy cannon, with an interval of a second or two between each report. This was followed by sounds like the firing of musketry, in quick succession, which ended with a rumbling noise like distant thunder, except that it continued with about the same degree of intensity until it ceased. It continued two or three minutes and seemed to come from the southwest, at an elevation above the horizon of 30 to 40 degrees, terminating in the

southeast, at about the same elevation. In the district where the meteorites fell, the explosions were heard immediately overhead.

The first reports were so heavy as to produce a tremulous motion, like heavy thunder, causing the glass in windows to rattle. The sound was so singular, that it caused some excitement and alarm, many supposing it an earthquake. At Barnesville, twenty miles east of Cambridge, the cry of fire was made, as the rumbling sound was thought to be the roaring of fire.

The day was cool and the sky covered at the time with light clouds. No thunder or lightning had been noticed that day; nor could any thing unusual be seen in the appearance of the clouds. Immediately on hearing the report, this observer looked in the direction it came, and noticed the clouds closely but could not see any thing unusual.

The next morning it was reported in Cambridge that aerolites had fallen on a farm in the vicinity of New Concord, (eight miles east, a little south of Cambridge), enquiries were immediately instituted, and Messrs. Noble and Hines state that they were near the house of a Mr. Amspoker at the time of the first explosion, which seemed directly over their heads. They looked up and saw two objects, apparently come through the clouds producing a twirling in the vapor of the cloud at the point, where they came through, then descending with great velocity and a whizzing sound to the earth—one striking about 300 yards to the southwest of them and the other about 100 yards north.

They immediately went to the spot where the first fell, and found it buried two feet in the ground. They dug it out and found it quite warm and of a sulphurous smell. The other struck a fence corner and breaking the ends of some of the rails penetrated into the earth sixteen or eighteen inches, passing through a heap of dry leaves; the first weighed 52 lbs., the other was broken up but must have weighed about 40 lbs. Another of 41 lbs. weight, not seen to fall, was discovered at the bottom of a hole two feet deep, where it had fallen on stiff turf, and was seen at the bottom of the hole, having carried the sod before it. It must have come from the southeast at an angle of 60° with the horizon. Many were discovered to have fallen southeast of Cambridge but of smaller dimensions than those already referred to. At the time of the occurrence nearly all were at dinner, or in and about their houses. The stones obtained were mostly found near houses, where they were seen to fall, as the sound of their striking the ground attracted attention.

Another well informed observer, Dr. McConnel of New Concord, (a small town eight miles east of Cambridge), furnishes the following particulars. On Tuesday, the 1st of May, at twenty-eight minutes past twelve o'clock, the people of that vicinity

were almost panic stricken by a strange and terrible report in the heavens, which shook the houses for many miles distant. The first report was immediately overhead, and after an interval of a few seconds, was followed by similar reports, with such increasing rapidity, that after the number of twenty-two were counted, they were no longer distinct, but became continuous and died away like the roaring of distant thunder; the course of the reports being from the meridian to the southeast. In one instance, three men working in a field,—their self possession being measurably restored from the shock of the more terrible report from above,—had their attention attracted by a buzzing noise overhead and soon observed a large body descending, strike the earth at a distance of about one hundred yards. Repairing thither they found a newly made hole in the ground, from which they extracted an irregular quadrangular stone weighing fifty-one pounds. This stone had buried itself two feet beneath the surface and when obtained was quite warm.

To this we add the following statement: "We the undersigned do hereby certify; that at about half past twelve o'clock on Tuesday, May the 1st, 1860, a most terrible report was heard immediately overhead, filling the neighborhood with awe. After an interval of a few seconds a series of successive reports, the most wonderful and unearthly ever before heard by us took place, taking a direction from meridian to southeast, where the sounds died away like the roaring of distant thunder, jarring the houses for many miles distant."

Signed by A. G. Gault, Jas. McDonnald, Nancy Mills, Ichabod Grumman, Samuel Harper, Rev. Jas. C. Murch, Mrs. M. Speer, Ang'e McKinney.

The above is from those who heard the noises but did not see the fall; the following are a few statements of the many I collected from those who witnessed the fall of the stones. I extract from their depositions made at the time.

"I heard the reports and roaring as above described. And a few seconds afterwards, I saw a large body or substance descending and strike the earth four or five hundred yards from where I then stood: and that I in company with Andrew Lister, repaired to the spot and about eighteen inches beneath the surface found a stone weighing fifty pounds." Signed by Samuel Reblu.

"Heard the reports and roaring as above described: and the said Mrs. Fillis further says, that a few seconds afterwards she heard a descending buzzing noise as of a body falling to the ground. And Miss Cherry also says that she was standing near Mrs. Fillis, heard the same and saw some substance descend and strike the earth some one hundred yards distant and that Mrs. Fillis repaired to the spot and there found a stone eighteen inches

beneath the surface weighing twenty-three pounds." Signed by Agnes Fillis, Mary J. Cherry.

"I distinctly heard the roaring and sounds as above described and a few seconds after the above report, I saw descending from the clouds a large body that struck the earth about one hundred and fifty yards from where I then stood, and I immediately repaired to the spot and about two feet beneath the surface found a stone weighing forty-two pounds, a second or two after seeing the first stone, I saw another descend and strike the earth about the same distance from where I stood, I also took the last mentioned stone from the earth about two feet beneath the surface; both the above stones when taken from the earth were quite warm. I also saw a third stone descend." Signed by Samuel M. Noble.

One observer saw a stone fall within three feet of his horse's head. One of the most southerly stones struck a barn; while some people retired within doors for fear of being struck.

These, with many others of a similar nature, were the data obtained near the region of the fall of stones. It is important to remember, that to these near observers no luminosity or fire ball was visible.

In addition to the above facts collected by ourselves, we have the following from observers at more distant points as already published by Profs. Andrews and Evans.

From the data they have collected, they consider the area over which the explosion was heard, as probably not less than one hundred and fifty miles in diameter. "At Marietta, Ohio, the sound came from a point north or a little east of north. The direction of the sound varied with the locality. An examination of all the different directions leads to the conclusion that the central point from which the sound emanated, was near the southern part of Noble county, Ohio," its course being "over the eastern end of Washington county, then across the interior of Noble county, then over the southwestern corner of Guernsey and the northeastern corner of Muskingum, with a direction of about 42° west of north."

"Mr. D. Mackley of Jackson county states that he was standing on the platform at the railroad station in Berlin, 20 miles south of Parkersburg, when he saw in a northeast direction, a ball of fire about 30° above the horizon. It was flying in a northerly direction with great velocity. It appeared as white as melted iron, and left a bright streak of fire behind it, which soon faded into a white vapor. This remained more than a minute, when it became crooked and disappeared."

Mr. Wm. C. Welles of Parkersburg, Virginia, (lat 39° 10′, long. 81° 24′,) about sixty miles south of Cambridge, saw the meteorite as a ball of fire of great brilliancy emerging from be-

hind one cloud and disappearing behind another. Other observers at some distance to the south of the point where the fall occurred saw this meteorite as a luminous body.

The above I conceive to be all the observations worthy of note concerning the fall of this meteorite.

The time of the day, and the number and intelligence of the observers, unite to give considerable interest and value to these observations. While some of them show points of difference, natural to the observation of sudden and startling phenomena, we can yet deduce from them many conclusions with more or less accuracy, thus:—

The direction of the Meteorite.—My own observations of two of the stones which fell half a mile apart, enable me to give the direction of the meteor with some degree of exactness. The first of these stones struck the end of the rails of a Virginia (zig-zag) fence, half way down, just touching the middle rail, breaking off more and more of each rail as it passed to the ground. Connecting the points of fracture by a line, this line represents a descending curve from S.E. to N.W.

Again, the stone that fell at Law's (the most northerly), struck a large dead tree laying on the side of a hill, sloping N.W., passing through it as any projectile would; it then struck a small clump of elders, breaking them off at the root, falling finally at the foot of the hill. A line connecting these points shows the curve already stated. Coupling with this the observation of Mr. Callahan, on the direction that one of these stones penetrated the ground, with the observed path of their distribution, no doubt can remain that the general direction of their fall was from S.E. to N.W., striking the ground at an angle of about 60°.

Altitude of the Meteorite.—This is a point that can be determined but very imperfectly if at all. It may have been when first seen 40 miles above the earth, but when the explosion was heard it must have been nearer and was even still nearer when it subdivided and was scattered ('exploded' as usually termed,) over Guernsey and the edge of Muskingum counties. It is, however, but proper that I should give Prof. Evans's computation from the data he collected; they were published in the July number of this Journal, but their reproduction will not be out of place here.

"Mr. William C. Welles of Parkersburg, Virginia (lat. 39° 10′, long. 81° 24′), a gentleman of liberal education, testifies that being about three miles east of that place at the time of the occurrence, he happened to look up to the northeast of him, and saw a meteor of great size and brilliancy, emerging from behind one cloud and disappearing behind another. When about 35° east of north he thinks its altitude was 65°. Now the distance, in a direction 35° east of north, from his station to the line directly under the meteor's path, is 20 miles. Calculating from

these data I find for the vertical height, taken to the nearest unit, 43 miles. This was at a point in Washington county near the border of Noble.

"Mr. C. Hackley testifies that he saw the meteor from Berlin in Jackson county. It crossed a cloudless space in the northeast, and he thinks its altitude, at the highest point, was 30°. Now the distance from Berlin to the nearest point under the meteor's path is 70 miles. These data give nearly 41 miles for its vertical height over Noble county, a few miles to the south of Sarahsville (lat. 39° 53′, long. 81° 40′).

"Many other reliable witnesses have been found who saw the meteor through openings in the clouds from various points west of its path; and whose testimony so far agrees with the fore going as to give results ranging between 37 and 44 miles. Care has been taken as far as possible to verify the data in each case by personal examintion of the witnesses. The angles have in most instances been taken as pointed out by them from their respective posts of observation. It is unfortunate that no case has come to our knowledge in which the meteor was seen from the region east of its path. But it was a circumstance in some respects favorable to the definiteness of the observations made from the west side, that the observers in nearly all cases saw the meteor only at one point, or within a very small space on the heavens. It is impossible to reconcile the various accounts without granting that its path was very nearly as above described, and that its height did not vary far from 40 miles as it crossed Noble county.

"In regard to the time which intervened, at different places, between seeing the fire-ball and hearing the report, the statements are so vague that not much reliance has been placed upon them. It may be remarked, however, that they will essentially agree with the foregoing conclusions, if we suppose that the loudest explosion took place in the southern part of Noble county.

"I will add under this head the statement of Mr. Joel Richardson, of Warren, Washington county, who from a place six miles west of Marietta, saw the meteor as much as 15° or 20° west of north, at an altitude of about 45°. The direction in this case was so oblique to the meteor's path, that the data are of little value for simply determining the height; but they are important on account of their connection with the place of the meteor's last appearance. Mr. Richardson was visited by the writer, and his testimony was subjected to close scrutiny. If we take the azimuth at 15° west of north, we shall have a distance of 41 miles to the line under the meteor's path; and these data will give about 41 miles for its vertical height over a point not more than a mile from New Concord, at the extreme western limit of the district along which the meteorites were scattered. If we take the azimuth at 20° west of north, both the distance and the

height will be greatly augmented. I have found two persons living near Bear Creek, nine miles north of Marietta, who make statements closely corroborating that of Mr. Richardson.

"D. Mackley, Esq., a lawyer of Jackson, Ohio, who at the time of the occurrence happened to be at Berlin, about six miles northeast from the former place, and seventy miles from the nearest point under the meteor's path. He took pains to note all the facts as accurately as he could at that time; and he afterwards returned to the spot in order to determine more definitely the points of the compass. His testimony, in answer to my interrogatories is substantially as follows:—

"The meteor first appeared to me at a point about 55° east of north. It moved northward in a line very nearly parallel with the horizon. When it disappeared it had described an arc of about 15°. It was in sight about 6 seconds. Its altitude was about 30°. In regard to its size, I have since looked at the sun through a thin cloud, and I think the apparent diameter of the meteor was one-half that of the sun."

"These data give the meteor a height of 41 miles over the northern boundary of Noble county; a diameter of three-eighths of a mile; and a relative velocity of nearly four miles a second. The results agree sufficiently well with those before given."

Temperature of the Stones.—Several of the largest stones were picked up ten minutes after their fall, and are described as being about as warm as a stone that had lain in the sun in summer. One fell among dry leaves that covered it after it had penetrated the ground; the leaves, however, showed no evidence of having been heated; no appearance of ignition was discovered in places or objects with which the stones came in contact at the time of their fall, so that their temperature must have fallen far short of redness, while it may not have reached that of 200°.

Size and Velocity.—I have no data upon which to calculate either of these. Prof. Evans, however, as just quoted, calculates from the data above given, that its size was $\frac{3}{8}$ of a mile and velocity four miles a second.

While I may furnish no more reliable computations from the data obtained, I may be excused a short criticism on the above results to prevent too hasty conclusions being formed.

As regards the supposed elevation of forty miles *when the first reports were heard*, I would simply ask the question, is it possible, with the established views of the conduction of sound by rarefied air that any conceivable noise produced by a meteorite forty miles distant from the earth, in a medium quite as rare if not rarer than the best air pump can produce, would reach us at all, or if so, in the manner described by observers? This question is a more important one to consider, as some observers on similar data have calculated the elevation of meteorites, where they were first heard to explode, at one hundred miles.

As regards the size of the meteorite, I have but to refer the reader to my experiments made in 1854, and published in this Journal in 1855,* to show the perfect fallacy of calculating the size of luminous objects by their apparent disks, and I shall have more to say on the same subject in a future paper. It is important to note that the nearest approach of the meteor to the earth must have been in the northern part of Noble and in Guernsey counties, the point from which its most wonderful display seemed to have manifested itself, yet we hear nothing of its future career by reports from observers north of this, while its approach from the south to this point was noticed by a number of observers.

I need hardly state my own convictions are, that the meteorite terminated its career in Guernsey county, and that the group of stones which constituted it were scattered broad cast over that county: many have been collected, and many lie buried in the soil to moulder and mingle their elements with those of this earth.

1.

We come now to consider the stones that fell and were collected. Their number was over thirty, and their places of falling have been plotted with some care in the accompanying map.

The localities of twenty-four have been fixed with precision, by the assistance of the Hon. C. J. Albright; but from the diminished scale of the map, it is impossible to place a number by each dot intended to represent the locality of a meteoric stone. No. 1 on the map is the spot where the largest stone was found, weighing 103 lbs. No. 2 is the next largest, weighing 56 lbs., and No. 3, the smallest, weighing 8 oz. The largest were at the northwest extremity, and smallest, at the southeast, the space over which they were scattered, was about ten miles long by three miles broad.

* Vol. xix, 340.

The following is a catalogue of 24:

No.	Weight.	Fell on farm of
1	103 lbs.	Shenholt.
2	56 "	Law.
3	52 "	Amspoker.
4	50 "	Amspoker.
5	41 "	Torrence.
6	36 "	Reasoner.
7	23½ "	Hodges.
8	26 "	Fillis.
9	16 "	Adair.
10	15 "	Craig.
11	8¼ "	Craig.
12	4½ "	Waller.
13	4 "	Beresford.
14	3¾ "	Craig.
15	3¾ "	Stevens.
16	3¾ "	Wall.
17	3 "	Walker.
18	2¾ "	Claysville.
19	2 "	Stevens.
20	2 "	Wall.
21	2 "	Savely.
22	1 "	Carter.
23	1 "	Heskett.
24	½ "	Heskett.

Others have been found but I have no correct record of their exact position.

Some fifteen of these stones have come under my observation; they are all irregular in shape, cuboidal, wedge-shaped, globular and every conceivable form that irregular fragments of stone may be supposed to possess; they all have the well-known black coating with a sharp outline between the coating and grey mass of the stone, and there is quite a uniformity in the character of the coating in both small and large stones.

When broken this meteor exhibits a grey mass, with metallic particles of nickeliferous iron,* resembling the stones I examined that fell in Harrison county, Indiana, on the 28th of March, 1859, the latter however is the coarser grained of the two. Prof. Shepard who is familiar with the meteoric stones preserved in the cabinets of this country and in Europe, says: "In its internal aspect it approaches the stone of Iekaterinoslaw, Russia, (1825), though it is somewhat finer and more compact. In crust the two are identical. It is also similar to the stone Slobodka, Russia, (Aug. 10th, 1818); and compares closely with those of Politz, (Oct. 13th, 1819), of Nanjemoy, Maryland, (Feb. 10th, 1828),

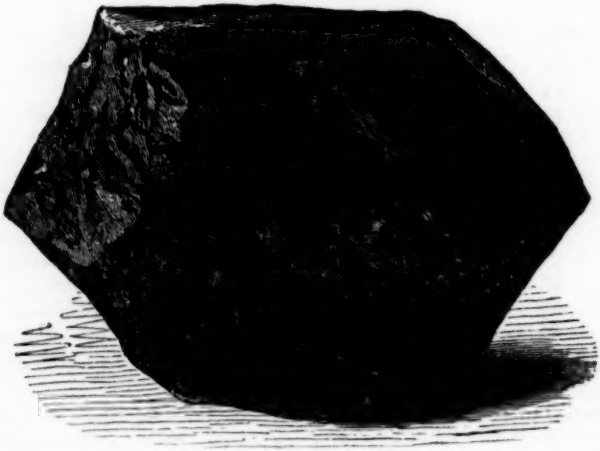
* I have picked out pieces of the iron weighing two grains, closely cemented to pyrites.

and of Kuleschowka, Russia, (March 12th, 1811), but the crust is less smooth on the Ohio stone than in that of the latter. In fact its character is, that of a large portion of the known meteoric stones."

The general thickness of the crust is about from $\frac{1}{30}$ to $\frac{1}{40}$ of an inch.

The following is the figure of the largest stone that has been found, now in the cabinet of Marietta College, and described by Prof. E. B. Andrews, (this Jour., July, 1860, page 104). We reproduce the figure from Prof. Andrews's article here cited.

2.



Several specimens have been examined, they all show the presence of the same minerals with a slight variation in their proportions as might be expected in a mass not homogeneous. Its composition is fairly represented as follows:—Specific gravity, 3·550, varying slightly in different specimens.*

In 100 parts, there are,—

Nickeliferous iron,	10·7
Earthy minerals,	89·3

The nickeliferous particles separated by a magnet from the crushed stone and well washed, presented the following constituents in 100 parts.

Iron,	87·011
Nickel,	12·360
Cobalt,	·421
Copper,	minute quantity not estimated.
Phosphorus,	·012
Sulphur,	1·080

* Mr. Johnson gives it as 3·5417, this Journal, [2], xxx, 111.

The sulphur comes from magnetic pyrites that the meteorite contains and that it is not easy to separate mechanically from the small particles of nickeliferous iron.

The earthy part when freed as thoroughly as possible from nickeliferous iron (which can be done pretty effectually by the magnet), was treated with warm dilute muriatic acid, thrown on a filter first washed thoroughly with water, then with a solution of potash to dissolve the last portion of the silica of the decomposed portion of the mineral. The result was in 100 parts:

Soluble portion,	63·7
Insoluble "	36·3

The earthy material analyzed as a whole was found to contain,

Silica,	47·30
Oxyd of iron,	28·03
Alumina,	0·31
Magnesia,	24·53
Lime,	·02
Soda, Potash,	1·04
Manganese,	*trace.*

From these results it is very clear that the mineralogical constitution of these meteoric stones is about as follows in 100 parts.

Nickeliferous iron,	10·690
Schreibersite,	·005
Magnetic pyrites,	·005
Olivine,	56·884
Pyroxene,	32·416

This sums up the history of this meteoric shower, with as full an account as possible of the stones that fell at that time. In the first part of this paper it was stated that this fall was quite as remarkable as that near L'Aigle in France in 1803. Although it does not equal this latter in the number of stones that were collected, it exceeds it in the size of the stones that fell. The largest of the L'Aigle stones weighed 17½ lbs., while the largest in the present case was 103 lbs.

There are many points of coincidence in the phenomena and circumstances attending the two falls. Were I to copy Biot's description of the phenomena of the fall at L'Aigle as detailed to the Academy of Sciences nearly sixty years ago, it would be but a repetition of what has been written in the first part of this paper.

The date of fall at L'Aigle was the 26th of April, the date of the Guernsey fall, May 1st; time of the day of the former, one o'clock, of the latter, twenty minutes of one. The direction of both falls from southeast to northwest. The extent of surface covered by the first seven and a half miles wide by two and a

half broad, by the latter, ten miles long by three wide. And both were seen by a large number of persons.

Since my memoir on meteorites was presented to the American Association for the Advancement of Science, and published, I have collected several important physical and chemical data that cannot be overlooked in the study of the nature and origin of these bodies. I will merely enumerate some of them now; reserving for a future occasion the proof upon which they are based and the deductions that may be drawn from them. 1st. The light emitted from meteoric stones does not arise from incandescence, but from electricity or some other cause. 2nd. That the noise attending their fall is not that arising from the explosion of a solid, but that it is by concussion of the atmosphere arising from the rapid motion of the body through it or in part due to electric discharge.

3d. That meteoric showers are not the results of fragments from the rupture of one solid body, but the separation of small and distinct aerolites that have entered our atmosphere in groups. 4th. That the black coating is not of atmospheric origin, but is already formed when these bodies enter our atmosphere.

I would also call the attention of those engaged in the examination of this class of bodies to the study of the true nature of their black coating, also to the fact that observers at a distance often see these bodies in a luminous state, while those situated where they fall, do not observe this luminosity.

ART. XII.—*Abstract of a Discussion of the Influence of the Moon on the Declination of the Magnetic Needle, from the observations at the Girard College, Philadelphia, between the years* 1840 *and* 1845; by A. D. BACHE, Superintendent United States Coast Survey.

THE existence of a sensible lunar effect on the magnetic declination has already been established by the labors of Brown, Kreil, Sabine and others. It is nevertheless important to add the weight of new numerical results to those already obtained.

In the discussion of the Philadelphia observations of magnetic declination already presented to the Association, I have shown how the influence of magnetic disturbances, of the eleven year period, of the solar diurnal variation and its annual inequality, of the secular change, and of the annual variation may be severally eliminated, leaving residuals from which the lunar influence is to be studied.

Each observation was marked with its corresponding lunar hour and the hourly normals used for comparison. This method

of treatment of the subject is that followed by General Sabine in his discussion of the results of the British observations. The details of the method will be better understood by an example.

The time of the moon's passage over the meridian of Philadelphia (upper transit) was obtained from the American Almanac, the small correction for the difference of longitude being neglected. The observation nearest to the local mean solar time of the moon's transit was marked with a zero, signifying 0^h of lunar time. The time of the inferior transit was next obtained, and the observation nearest to it in time was marked 12^h. The greatest difference in interval between the moon's transit and the time of observation could in no instance exceed half an hour. In the bi-hourly series the observations nearest the moon's transit, or to either hour angle, one hour before or one hour after the transit was marked. The mean of a number of differences for the same hours will thus give a result corresponding sufficiently near to the hour. The number of observations intermediate between those marked 0^h and 12^h were marked with the corresponding hour angle by interpolation, care being taken to note the nearest full hour against each observation in the bi-hourly series. The hourly series begins with October, 1843. In the case of thirteen observations within twelve lunar hours, the one nearest midway between the two consecutive lunar hours was omitted.

The month of March, 1842, is selected as an example of working the bi-hourly series, and the tables are given in the complete paper which, it is expected, will be published in the Smithsonian Contributions to Knowledge.

One of the first questions to be determined is, how many of these residuals must be used to give a definite result, another one is, whether numbers deduced from different parts of the series would give harmonious results. To test both of these the observations were formed into three groups, one containing 4900 in 19 months of 1840 and '41; another 6715 results in 21 months of 1842 and '43; and a third 10029 results in 18 months of 1844 and '45; in all 21644 results.

The tables for the several months and for each year, showing the residuals for each lunar hour, are given in the complete memoir in detail, as also the results of the discussion of groups I and II, and of III, in which all the observations are united. Special investigation showed that the weights were nearly proportional to the number of observations, a result which indicates that no undue constant errors influence the result.

The results of the discussions of these three groups were also expressed by Bessel's formula and treated by the method of least squares. Two terms of the formula suffice to represent the observations, and there is no constant term, indicating that

the moon has no specific constant action of deflection on the needle. The coefficient of the first term is small, the character of the curve depending chiefly upon the second term which produces a double crested curve showing two eastern and two western deflections in one lunar day. The difference in the amount of the eastern and of the western ranges depends upon the coefficient of the first term. The progression of the hourly values is systematic, and the agreement between the computed and observed values is satisfactory. On the Diagram B, the observed values are indicated by dots and the smooth curve results from the equation.

The difference between the curves of deflection for the eastern and western hour angles shown in the curve, enables us to determine the diurnal lunar tide and is drawn on the plate and represented by the first term of the formula. The interference of the two curves gives the observed form.

The curves all agree in their distinctive characters, and show two east and two west deflections in a lunar day, the maxima W. and E. occurring about the upper and lower culminations and the minima at the intermediate six hours. The total range hardly reaches 0″·5. These results agree generally with those obtained for Toronto and Prague. From 8000 to 10000 observations seem to be required to bring out the results satisfactorily, and the best results are derived from the use of both groups. The principal western maximum occurs six minutes after the lower culmination of the moon and amounts to 0″·23. The secondary maximum occurs fourteen minutes after the upper culmination and amounts to 0″·18. The principal maximum occurs at $6^h\ 17^m$ after the lower culmination, the easterly deflection being 0″·22. The secondary maximum at $6^h\ 03^m$ after the upper culmination has a deflection of 0″·19. The greatest range is 27″ and the secondary 22″. The epochs of the maxima and minima are found from the formulæ to be at a mean, ten minutes after culmination. The probable error of a single computed value of the lunar diurnal variation is ±1″·32. The Toronto observations gave ±1″·37 from more than twice the number of observations, so that the Philadelphia observations appear to be worthy of every confidence. At Toronto from the second investigation, embracing about 44,000 observations, the western and eastern deflections balanced, giving for the range 38″·3. The Prague observations also confirm the nearly equal deflections (mean) to the west and east. The epochs of the maxima and minima were found from the four roots of the equation $0 = 0{\cdot}029 \cos(\theta + 295°) + 0{\cdot}414 \cos(2\theta + 85°)$ which gave ten minutes as the mean time elapsed between the moon's passing the meridian and the time of maxima of deflection. If we take the four phases into account the lunar action seems to be retarded ten minutes, which may be termed the *lunar*

magnetic interval for the Philadelphia station. At Toronto the intervals are not so regular. The secondary range exists there, and is also a marked feature in the Prague results.

The lunar diurnal variation seems to be the subject of an inequality depending on the solar year, for the investigation of which the preceding results were rearranged in two groups, one containing the hourly values for the summer months (April to September), the other the values for the winter months (October to March). For the summer season we have 11087 observations, and for the winter 10557.

In the complete memoir the tables of the hourly sums of the lunar variations for the summer and winter seasons are given, and the tabular results are expressed analytically. The curves representing them are shown in the annexed Diagram C.

The characteristic feature of the annual inequality in the lunar diurnal variation is, therefore, a much smaller amplitude in winter than in summer. Kreil indeed inferred from the ten year series of the Prague observations that in winter the lunar diurnal variation either disappears or is entirely concealed by irregular fluctuations, requiring a long series for their elimination. The method of reduction which he employed was however less perfect than that now used. The second characteristic of the irregularity consists in the earlier occurrence of the maxima and minima in winter than in summer. The winter curve precedes the summer curve by about one and three quarter hours. Both these features are well expressed in the diagram C. At Toronto the same shifting in the maxima and minima epochs was noticed, but the other irregularity in the amount of deflection is not exhibited. It seems probable that the Philadelphia results are more typical in form than those either of Prague or Toronto.

It is also apparent that the smaller deflection at the upper culmination in the annual mean, when compared with the deflection at the lower culmination, is entirely produced by the feeble lunar action in winter. The maximum west deflection in summer occurs actually near the upper culmination. At the same season the maximum east deflection is still retained (as in the annual curve) about six hours after the lower culmination. In the winter season this last mentioned maximum east deflection is actually the smaller of the two. We have

Maximum summer range,	- - -	35″·4, secondary	31″·8
" winter "	- - - -	25 ·2, "	15 ·6
difference,	- - - -	10 ·2,	16 ·2

At Prague the maximum summer range was 44″.

I next proceed to examine whether the phases, declination or parallax of the moon, have any sensible effect upon the magnetic declination. Dr. Kreil found from a ten years series

of observations at Prague, that there was no specific change in the position of the magnet depending upon the moon's phases and parallax, but that the declination was 6″·8 greater when the moon was at the greatest northern declination than when at the greatest southern declination. On the contrary Mr. Brown from the Makerstoun observations, a much shorter series than the one at Prague, inferred that there was a maximum of declination two days after the full moon. He also found a maximum corresponding to the greatest northern declination of the moon, but does not appear to have investigated the effect of distance.

The residuals which we have been treating enable us at once to examine these several points.

Beginning with the lunar phases, the daily means for the day of full and new moon, and for two succeeding days, were compared with the monthly mean declination. In case any of the hours were disturbed, the monthly normal for the hour was substituted for the disturbed observation before the mean was taken. If one half or more of the hourly readings were disturbed, the daily mean was altogether omitted. Accidental omissions of hourly observations were supplied by the hourly normal. The half monthly normals were then compared with the half monthly means. In the table of differences thus formed equal weight is given to the bi-hourly and hourly observations. The daily mean having been subtracted from the monthly mean, the positive sign indicates a western deflection and the negative sign an eastern one, as compared with the normal position. The following table contains the results:

	Sum of deflections.	Number.	Deflection.		
			d.		
Full moon,	+11·6	52	+0·22	+0″·10	±0″·07
1st day after,	− 7·1	51	−0·14	−0 ·06	
2d day after,	− 9·3	48	−0·19	−0 ·08	
New moon,	−11·5	43	−0·27	−0 ·12	±0″·09
1st day after,	+ 1·5	47	+0·03	+0 ·01	
2d day after,	+ 4·4	49	+0·09	+0 ·04	

The effect is very small, scarcely much beyond the probable error; but the table indicates that the north end of the magnet is deflected to the westward 0″·1 at the full and as much to the eastward at the day of new moon, the range between full and new moon being 0″·2. A more definite result could hardly be expected from a series of observations extending over but five years.

Treating the effect of the moon's variation in declination in precisely the same manner we obtain the following results:

	Mean deflection.			
One day before,	−0′·20	from	54	days of observation.
At moon's max. declin.,	−0′·10	"	53	"
One day after,	−0 ·09	"	55	"
Mean,	−0 ·13	"	162	"
One day before,	−0 ·04	"	54	"
At moon's min. declin.,	−0′·07	"	52	"
One day after,	+0 ·14	"	52	"
Mean,	+0 ·01	"	158	"

The results do not positively prove a deflection of the magnet depending on the moon's greatest north and south declination. The amount resulting from the comparisons being of nearly the same magnitude as its probable error.

A similar investigation with respect to the moon's distance from the earth gives the following results.

	Mean deflection.			
One day before,	−0′·18	from	50	days of observation.
At moon's perigee,	−0 ·18	"	41	"
One day after,	−0 ·00	"	59	"
Mean,	−0 ·12		150	
One day before,	−0′·02	"	55	"
At moon's apogee,	−0 ·20	"	53	"
One day after,	−0 ·13	"	47	"
Mean,	−0 ·12	"	155	"

The difference being of the same order of magnitude as the probable errors, no conclusion as to the effect of distance can be drawn from them.

I propose hereafter to extend the discussion of the moon's effect on the declination to the effect on the earth's magnetic force.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On the Chemical Analysis of the Solar Atmosphere.*—KIRCHHOFF has communicated some further results of his remarkable investigations on the constitution of the solar atmosphere, a notice of which has already been given in this Journal. The author maintains that the sun has an ignited gaseous atmosphere which encloses a core of still higher temperature. If we could see the spectrum of this atmosphere, we should detect the bright lines which are characteristic of the metals existing in it, and should recognize the metals themselves from these. The more strongly luminous body of the sun does not however permit the spectrum of his atmosphere to appear. It inverts this spectrum so that instead of the

bright lines which the spectrum of the atmosphere alone would exhibit, dark ones make their appearance. We see therefore, only the negative image of the spectrum of the sun's atmosphere.

In order to study the solar spectrum with the requisite degree of accuracy, Kirchhoff procured from the workshop of Steinheil an apparatus consisting essentially of four large flint glass prisms and two telescopes.

With this apparatus the spectra are seen in a hitherto unattainable degree of distinctness and purity. It exhibits in the solar spectrum thousands of lines with such clearness that they are easily distinguished from each other. It is the author's intention to draw the whole spectrum as seen with his apparatus, and he has already done this for the portion which lies between Fraunhofer's lines D and F.

This apparatus exhibits the spectrum of an artificial source of light with the same distinctness as the solar spectrum, provided only that the intensity of the light is sufficient. A common gas flame in which a metallic compound evaporates, is usually not sufficiently luminous but an electric spark gives with the greatest distinctness the spectrum of the metal of which the electrodes consist. A large Ruhmkorff's induction coil yields electric sparks in such rapid succession that the spectrum can be observed as easily as that of the sun.

A very simple arrangement permits the comparison of the spectra of two sources of light. The rays of one of the sources may pass through the upper half of the vertical slit, while those of another pass through the lower half. When this is the case, one of the two spectra is seen immediately beneath the other, and it is easy to determine whether coincident lines occur in both.

In this manner the author satisfied himself that all the bright lines peculiar to iron correspond to dark lines in the solar spectrum. In the portion of the spectrum between D and F, about 70 particularly well-marked lines occur, resulting from the iron in the sun's atmosphere.

Iron is remarkable on account of the great number of distinct lines which it produces in the solar spectrum; magnesium is interesting because it produces the group of Fraunhofer's lines lying in the green denoted by Fraunhofer by *b*, and consisting of three very strong lines. Very distinct dark lines in the solar spectrum correspond to the bright lines produced by chromium and nickel, and we may therefore regard the presence of these substances in the sun's atmosphere as proved. Many other metals appear however to be wanting in the sun's atmosphere. Silver, copper, zinc, lead, aluminum, cobalt and antimony have extremely brilliant lines in their spectra; but no distinct dark lines in the solar spectrum correspond to these.

Many metallic compounds do not give in a gas flame the spectrum of their metal, because they are not sufficiently volatile: in these cases the spectrum may be made to appear by means of the electric spark. It is true that in this case the spectrum of the metal of which the electrodes consist and that of the air in which the spark passes is also seen. To avoid the difficulty arising from the very great number of bright lines of which the spectrum of every electric spark consists, it is necessary to have recourse to a particular arrangement. The electric spark is allowed to pass at the same time between two similar pairs of elec-

tro'es, the light of one spark being allowed to pass through the upper, that of the other through the lower half of the slit, so that one spectrum is seen above the other. When the two pairs of electrodes are clean, the two spectra are perfectly similar: when however a metallic compound is placed upon one pair, the corresponding spectrum immediately shows the lines belonging to the metal introduced. The author has satisfied himself that in this manner even the metals of the rare earths, yttrium, erbium, terbium, etc., may be recognized most quickly and certainly. It is therefore to be expected that by the help of Ruhmkorff's apparatus, the spectral method of analysis may be extended to the detection of all metals. The researches which the author has undertaken in connection with Bunsen will, it is hoped, determine this point.—*Journal für prakt. Chemie, No.* 16, 1860.

2. *On a New Alkaline Metal.*—Bunsen has discovered in the waters of several mineral springs, a new alkaline metal, the existence of which was first detected by the spectral method of qualitative analysis, already noticed in this Journal. The new alkali exists in these waters together with potassium, sodium, and lithium, and its presence may be shown by the spectral analysis with the greatest facility, although only a few milligrammes are contained in several kilogrammes of the material. The author gives only a very brief preliminary notice of the new metal, promising a more extended investigation. The chlorid may be distinguished from the chlorids of sodium and lithium by the yellow precipitate which it gives with chlorid of platinum. It is distinguished from potassium by the solubility of its nitrate in alcohol. The vapors of the compounds of this metal, when heated so as to become luminous, give an extremely characteristic spectrum, which at the same time exhibits the remarkable simplicity of the spectra of the other alkaline metals. Its spectrum consists of only two blue lines—a weaker line, corresponding with the blue strontium line and another which lies only a little farther toward the blue end of the spectrum, and which vies in intensity and sharpness of definition, with the red line of lithium.—*Journal für prakt. Chemie*, 16, 1860.

3. *On the colors of Flames.*—Merz has communicated some investigations on the coloration of the flames of Bunsen's burner and of hydrogen gas produced by the presence of various substances. These observations may be considered as supplementary to those of Bunsen already noticed in this Journal, and although less certain, are simpler and more easily applied than the processes of the spectral analysis. The author employs a flame of pure hydrogen as well as that of Bunsen's burner, and in addition, makes use of blue, violet, red and green glasses. The new substances which he describes as giving characteristic colors to the flame of Bunsen's burner, are nitric, chromic and molybdic acids, while phosphoric and sulphuric acids give a peculiar coloration to the dark core of the flame of hydrogen.

The flame of Bunsen's burner gives three sorts of colors—*a.* Border colors. These are of course peculiar only to the most volatile substances. To produce them, the loop of platinum wire is to be held outside of the flame about one or two millimeters from the lower portion of the outer limit *b.* Mantle colors—those namely which are seen when the substance

is held in the bright blue colored mantle which forms the outer portion of the flame. *c.* Flame colors. To produce these, the loop is to be held horizontally and in the hottest part of the mantle. The hydrogen flame yields another species of color—viz, the core colors. These are produced only by sulphuric and phosphoric acids, which communicate respectively a blue and green tinge to the cold core of the hydrogen flame.

Nitric and nitrous acids give a bronze green border color, usually with an orange colored border. The test is to be previously dried in the flame, and dipped into a solution of bi-sulphate of potash, or into dilute muriatic acid, according as we wish to test for nitric or nitrous acid. The sensibility is about $\frac{1}{40}$ mgrm. Compounds of ammonia and cyanogen give the same bronze green border, but more faintly.

Phosphoric acid gives a grey-yellow-green border color, as well as a beautiful green core color. The dry test is to be dipped into sulphuric acid and held in the flame in the manner above pointed out, in order to show the border color. The sensitiveness is $\frac{1}{8000}$ mgrm. The green core color is less sensitive, but indispensable in recognizing phosphoric acid in the presence of large quantities of boric acid, and is produced by alternately moistening the test with a solution of fluosilicic acid, and holding it till ignition in the hydrogen flame, until the color distinctly appears.

Sulphuric acid produces a beautiful blue core color, being reduced to sulphurous acid. Free sulphuric acid gives the color when the platinum loop is held in the border of the flame, but a sulphate must be held in the middle of the flame. In the latter case, it is well to dip the test into strong muriatic or fluo-silicic acid. The sensibility for sulphuric acid is $\frac{1}{4000}$ mgrm., for a sulphate, $\frac{1}{1000}$ mgrm.

Boric acid gives a beautiful green mantle color, which is so intense that the acid may be recognized in the presence of large quantities of phosphoric acid. The sensibility $\frac{1}{1400}$ mgrm. Borates are to be decomposed with sulphuric acid.

Chromic acid gives a dark brownish red border color, and a rose red mantle color. The sensibility is $\frac{1}{1000}$ mgrm. The dry test is to be moistened with concentrated sulphuric acid, and held in the border. Oxyd of chromium gives no color, and is to be first oxydized to chromic acid by moistening with a solution of hypochlorite of soda, and drying. Molybdic acid gives a yellowish green flame-color like that of baryta, which is however very fleeting, and only occurs on moistening the test with muriatic acid.

Muriatic acid gives a very weak greenish blue border-color, which lasts for a very short time, and therefore does not deserve attention. The acid is however decomposed into free chlorine which may easily be recognized.

Potash gives a grey blue mantle-color and a rose violet flame color. These colors appear reddish violet through the blue glass, violet through a violet glass, and blue green through a green glass. Potash is recognized in the presence of lithia, as well as through so thick a layer of blue glass that the lithium red is no longer visible. The test is to be moistened with sulphuric acid, and repeatedly exposed to the flame for a short time. The sensibility is $\frac{1}{31000}$ mgrm., for blue, $\frac{1}{15000}$ mgrm. for green glass.

Soda gives an orange yellow flame-color, which in very large quantities appears pure blue, but in small quantities is invisible through the blue

glass; through the green glass, the soda flame appears orange yellow, even with the smallest quantities. This glass is particularly adapted to the recognition of soda in all its compounds. The sensibility is $\frac{1}{280.000}$ mgrm. The test is to be moistened with sulphuric acid; dried and held in the hottest point of the flame.

Lithia gives a carmine red flame-color which appears violet red through the blue, carmine red through the violet but is invisible through the green glass. The test is to be moistened with sulphuric acid and treated like potash, the sensibility is $\frac{1}{140.000}$ mgrm. In the presence of soda, lithia is recognized through the blue glass; in the presence of potash, by the method given by Bunsen. In the case of the alkaline earths, the test is to be moistened with sulphuric acid, carefully dried, and held in the hottest point of the mantle. After all the alkalies have evaporated, the earths may be detected.

Baryta may be recognized by the yellowish green flame-color which appears blue green through the green glass. The sensibility for baryta alone is $\frac{1}{85.000}$ mgrm. If the green disappears and a red flame-color makes its appearance, the test is to be repeatedly moistened with muriatic acid, and immediately introduced while wet into the hottest part of the flame. If the blue green color is no longer seen, we proceed to examine for lime.

Lime is present when the red flame-color, on evaporating the last portion of muriatic acid, appears siskin green through the green glass. Strontia gives in this case a weak yellow. The sensibility of lime alone is $\frac{1}{70.000}$ mgrm., but by employing the green glass, $\frac{1}{18.000}$ mgrm.

Strontia may be recognized by the purple or rose color which is seen through the blue glass when the test, after moistening with muriatic acid, is evaporated to dryness in the flame.

Copper as chlorid gives an azure blue zone, and as nitrate, a pure green flame-color. By the combined observation of both colors, copper may be distinguished from all other metals which give similar colors. The sensibility of copper alone is $\frac{1}{3.000}$ mgrm. The other flame-coloring metals, such as arsenic, antimony, tin, lead, mercury and zinc, exhibit especially in the form of chlorids, more or less intense bluish or greenish mantle-colors, which however cannot be advantageously used as reactions for the metals themselves.—*Journal für prakt. Chemie*, No. 16, 1860.

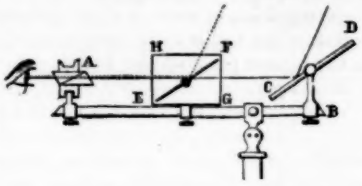
4. *The Dichroscope.*—The apparatus to which Prof. Dove has given this name is intended for the following purposes:—

(1.) To represent interferences, and spectra in different-colored light, both separately and combined.

(2.) To imitate the phenomena of dichroism, both in the case in which dichroitic crystals are viewed through Haidinger's rhomb of calc spar, and also in the case of the phenomena produced when the dichroitic crystals themselves are used as analyzers in a polariscope.

(3.) To combine elliptically, circularly, and rectilinearly polarized and unpolarized light, not in such a manner that the one is produced by the polarizing, and the other by the analyzing arrangement, but so that they traverse the doubly refracting media simultaneously, and are then submitted to any analyzing arrangement.

HEGF is the dichroscope which is placed in a polariscope as indicated in the figure; A, being the Nicol's prism, and CD the polarizing mirror.



It is a brass box 81 millim. long, 75 high, and 70 broad, three sides of which are open; these sides, HE, HF, FG, can be closed by opaque slides, or by plates of colored glass; a single glass plate, or sets of glass plates, can also be inserted in the direction EF, as seen in the figure. The side HE, is destined to receive cooled glasses, crystals, or a rotating circular-polarizing plate of mica. The side HE, can be closed by a slide having in it a slit for prismatic analysis or a circular aperture for experiments, with fine gratings. Two mirrors belong to the apparatus: one is silvered, the other blackened.

It being assumed that the linear analyzing arrangement is so placed that in a crystal of calc spar cut at right angles to its axis and placed between A and HE, the rings and black cross are visible, the following combinations may be obtained.

1st. Employing CD the silvered mirror and EF the glass plate: ordinary light reaches the analyzing prism from CD and linear polarized light from EF.

(*a.*) FG closed by an opaque slide: white linear-polarized light.

(*b.*) FG closed by the slide, in HF a colored glass: according to the nature of the glass, monochromatic or polychromatic linear-polarized light.

(*c.*) Colored glass at FG, HF open: unpolarized colored light and white linear-polarized light. The cross is seen brightly colored in the tint of the glass.

(*d.*) A colored glass at HF, FG open: colored polarized light with unpolarized white light. The rings become almost invisible.

(*e.*) Differently colored glasses at HF and FG. The rings appear as if the analyzing prism had been turned 90°; the cross is colored and the rings appear in the tints of the two glasses.

(*f.*) If a rotating mica plate be placed at HE the corresponding combinations of circular and elliptical, with unpolarized light are obtained.

2d. The silvered mirror CD is replaced by the blackened polarizing mirror. Two beams of light linearly polarized in the same plane, or if the mica plate at HE is used, circularly or elliptically polarized, reach the Nicol's prism.

They are (*a*), both white or both colored, (*b*) white and colored, (*c*) differently colored, according to the arrangements made.

3d. Between the mirror CD and the plate of glass EF, the mica plate is inserted: in this manner combinations of circularly or elliptically polarized light, with linear polarized light are obtained.

4th. The silvered mirror is placed at CD and a set of six glass plates is inserted at EF. This is so arranged that the light entering from CD and polarized by refraction in passing through EF is equal in intensity to the light polarized by reflexion at EF: the two beams are of course polarized

at right angles to each other; no figure is formed by the crystal of calc spar—the light is unpolarized.

Interesting experiments may be be made by weakening the intensity of either of these beams of light. If now colored glasses are placed in HF and FG the phenomena of dichroitic crystals may be obtained, as follows:—

(*a.*) The calc spar crystal is removed, and the Nicol's prism exchanged for a doubly refracting rhomb of calc spar. When a round aperture is inserted at HE, two images of it are obtained in different colors; by rotating the rhomb the tints pass into one another.

Crystals improperly termed dichroitic are now represented by using plates of glass of the same color, and weakening the intensity of one of the beams of light.

(*b.*) If a crystal of calc spar cut at right angles to its axis is inserted between A and HE the phenomena are obtained which dichroitic crystals exhibit when they are used in a polarizing apparatus as an analyzing arrangement.

By the intermixture of certain spectra Prof. Dove obtained colors which could not have been expected from the components, but which corresponded to the investigations of Wünch and Helmholtz.

Prof. Dove remarks that his dichroscope can with some inconvenience be adapted to the Nörremberg polariscope.

The little polariscope figured on page 536 (or 388, 2d edition) of Silliman's Nat. Phil. is however admirably adapted to its reception as I have ascertained experimentally.—*L. and E. Phil. Mag., No.* 134, *Nov.*, p. 352.

O. N. R.

5. *Dove's 'Optical Studies.'* *—(1.) Prof. Dove found in 1851, that by combining black and white surfaces in the stereoscope metallic lustre was produced, and upon this and similar experiments founded a theory of lustre. In his Optische Studien he describes a method of producing lustre without stereoscopic combination. A pattern cut out of red paper is pasted on a sheet of green paper or the reverse arrangement may be adopted. If a plate of red glass is held before one eye and one of green before the other, the picture is seen brilliant and lustrous as though painted on glass or porcelain. A blue figure on a red field, or the reverse, when viewed through red and blue glasses give similar results.

The lustre is most striking when the drawing is viewed from above.

(2.) *On a method of mingling at will colors produced by absorption or interference.*—see Dichroscope, this Journal p. 108.

(3.) *On the influence of binocular vision upon the estimation of the distance of bodies seen by reflexion and refraction.*—The following is a striking experiment. A cube of clear glass 2 inches in diameter was placed upon a colored glass cube 1 inch in diameter. When viewed with both eyes from above, the colored glass appeared to be converted into a four sided prism of double the height. (A piece of glass 1 inch thick with two parallel sides, placed on a cork $\frac{1}{2}$ inch in diameter shows this very deceptive phenomenon quite well.) If print be viewed through a large rhomb of calc spar by both eyes it will be seen that the two images do

* Optische Studien, by Prof. H. W. Dove, Berlin, 1859.

not lie in the same plane. This effect is imitated by Prof. Dove in two printed stereographs—see Sept. No. this Journal, p. 304.

[If a printed page be magnified by a plane convex lens 3 inches in diameter 2½ in focal length, and viewed by both eyes, it will be seen that the letters are raised in the centre of the field, so that it instead of appearing flat seems to be convex. A single projection of a pyramid placed under the centre of the lens gains relief, though the lines drawn from the base to the apex rise toward the observer in curves. The effect is due to the distortion produced by viewing the drawing through the opposite halves of the lens.

On the other hand if two perfectly similar printed pages be viewed through the lenticular stereoscope, attentive examination will show that the field is apparently concave: the lines rising in shallow tiers, above and below; this is of course a defect in the instrument, since it alters the relief in which the objects are seen, increasing or diminishing it according to their position in the field.

On this account it may perhaps be advisable even where the most natural relief is desired to place the cameras somewhat farther apart than the distance between the eyes. Sir David Brewster, in his work on the stereoscope, page 108, gives us to understand that Wheatstone's reflecting stereoscope is not a "real optical instrument"(!) because pieces of *looking-glass* are employed in it. Must we now strike Sir David's lenticular stereoscope from the catalogue of optical apparatus because *semi-lenses* are employed in it, which alter the natural relief, in which according to the same author it is so *essential* that objects should be viewed?]

(4.) *An interesting article on the application of the Stereoscope to distinguish copies from fac-similies.*—When two pages printed from the same type are combined in the stereoscope the printing appears to lie in the same plane—(in the lenticular stereoscope to be evenly distributed over a shallow concave surface). In the most careful attempt by the printer to set up a page or a few lines alike, the words and letters will in the stereoscope be seen to lie in different planes.—(See the illustration on page 304, vol. xxx, this Journal.)

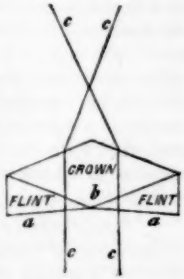
By this means when genuine and counterfeit bank notes are combined in the stereoscope the difference is at once detected. This is really a method of apparently converting distance in a horizontal, into depth in a vertical plane and greatly magnifying it.

(5.) *Upon the Electric Light,*—being an analysis of the weaker varieties of electric light by means of colored glasses. In passing from nearly invisible electric light to the electric spark, the changes are as though the spectrum was slowly uncovered by the withdrawal of a screen whose motion was in a direction from the violet toward the red. This makes it improbable that the increase of intensity in electric light is due to an increase of heat in the particles torn from the conductors. The action is more like that of the pale flame of hydrogen which becomes bright and white by the introduction of solid matter. O. N. R.

6. *Improvements in the Microscope.—Wenham's Improved Binocular Microscope.*—In the Quarterly Journal of Microscopical Science for July, 1860, Mr. Wenham has described an improved form of Binocular Microscope. The construction of this instrument will be understood from the

accompanying figures. The rays from the two sides of the object glass are transmitted through a compound achromatic prism shown in fig. 1, by which they are made to cross each other and diverge at an angle of 16°, so that at the distance of about eight inches the rays from the right side of the object enter the left eye, and the rays from the left side enter the right eye as shown in fig. 2.

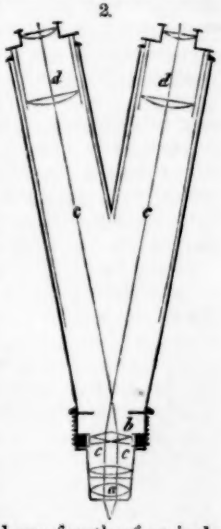
1.



Two prisms of flint glass *a a*, fig. 1, are cemented to a single four-sided prism *b* of crown glass; the angles of the prisms having such a relation to the refractive and dispersive powers of the two kinds of glass as to make the compound prism achromatic and give to the opposite pencils the proper convergence after leaving the prism. In an instrument of this kind, made under the direction of the writer, by Messrs. Grunow, the flint prisms have each a refracting angle of 26°, the lateral angles of the crown prism are 44°; the opposite faces of the crown prism are parallel; the refractive index of the flint glass is 1·621 and of the crown glass 1·534 and the dispersive powers of the flint and crown prisms are as 1·000 : 0·625.

In fig. 2, *a* represents the object-glass of the microscope, *b* is the compound prism, *c c*, *c c* show the position and direction of the two lateral pencils, and *d d* are two eye-pieces at the extremities of the two branches of the compound body and the microscope.

2.



Each branch of the compound body is furnished with a draw-tube which can be extended 2 or 3 inches if necessary. By this means the instrument can be adjusted to different eyes. When the draw-tubes are closed, the distance between the centres of the eye-pieces is 2 inches, and when drawn out two inches, the distance apart is 2½ inches. This is as great a range as is required to suit the eyes of most persons who wish to use the microscope.

A great superiority of this binocular microscope over other forms, as Nachet's and Riddell's, results from the extreme thinness of the achromatic prism. In both of the other forms named, the light twice suffers total reflection, and passes through a thickness of an inch or more of glass causing much aberration and loss of light. In the form described above there is little loss of light or aberration, as the greatest thickness of the achromatic prism does not exceed one fourth of an inch. Another excellence is the lightness and simplicity of construction and the facility with which it may be adapted to the ordinary microscope. In microscopes having a horizontal arm, the ordinary compound body can be changed for the binocular body and either may be used at pleasure. The instrument of this kind made for the writer gives great satisfaction

to all who have seen it. The stereoscopic effect is perfect; vascular and cellular tissues, and mucous membranes are shown in bold relief; and a magnifying power of 200 to 300 diameters can be used with reflected light with entire satisfaction. With transmitted light the higher powers can be used on suitable objects.

Note.—There is one defect in this form of binocular microscope, viz., object glasses of large angular aperture take in light from so great a field that a portion of light enters the branch of the compound body on the same side from which it originates. This gives, with *low powers*, as the 1 inch and 2 inch objectives of large apertures, a supernumerary image that interferes somewhat with the definition of that part of the field under examination. This defect diminishes as the objective is removed to a greater distance from the prism. If this defect can be obviated, this form of binocular microscope will undoubtedly prove greatly superior to all other forms yet devised. M. C. White.

New Haven, Dec. 7, 1860.

7. *Tolles' Orthoscopic Eye-piece.*—Among the recent valuable improvements of the microscope we notice as worthy of mention a new form of eye-piece made by Mr. R. B. Tolles, of Canastota, N. Y. This is a modification of the Solid Negative Eye-piece for which Mr. Tolles received a patent, Sept. 1855. The new eye-piece consists of a double convex field-lens, about three-fourths of an inch thick, and a plano-convex eye-lens. The image is formed in the solid substance of the field-lens. This instrument is so constructed as to give a flat field, the central and lateral portions being in focus at the same time, and the magnifying power is the same throughout, so that lines are shown perfectly straight in whatever part of the field they may be seen. Mr. Tolles also combines a micrometer with this eye-piece, by constructing the thick field-lens of two parts cemented together and by ruling micrometer lines on one of the plane surfaces of union. This eye-piece either with, or without the micrometer is highly satisfactory, giving very fine definition throughout the entire field. This eye-piece will be received with great favor by all who work with the microscope. M. C. W.

8. *Contributions to Analytical Chemistry.*—From an elaborate memoir by H. Rose, we extract the following notices which are of special interest and importance.

Alumina from Lime and Magnesia.—In the ordinary method of separating alumina from lime and magnesia by means of ammonia, the precipitate of alumina is apt to contain portions of the carbonates of the earths, which of course cannot be removed by washing. To avoid this difficulty, it is only necessary after precipitating by ammonia, to boil the whole gently until there is no longer any smell of free ammonia. In this manner, the alumina is completely precipitated while the whole of the carbonate of lime or magnesia is decomposed and dissolved by the ammoniacal salt present. It is of course necessary that chlorid of ammonium or some other ammoniacal salt should be present in sufficient quantity.

The precipitated alumina is very difficult to wash out upon the filter; it is therefore better after bringing it completely upon the filter, to dry the whole partially till the alumina has shrunk together and just moistens the paper when pressed against it. The alumina may then be easily and

completely washed with hot water. The separation of lime from alumina by this method is complete, but extremely small traces of magnesia usually remain with the alumina.

Separation of Oxyd of Iron from Lime and Magnesia.—By precisely the same method, oxyd of iron may be separated easily and completely from both lime and magnesia. The oxyd of iron may be readily washed out by hot water, and is not gelatinous like alumina.

Separation of Alumina and Iron from Manganese.—Alumina may be easily separated from manganese by the same method. The precipitated alumina sometimes however contains traces of manganese which are too small to be detected by the blowpipe. The same process may be employed directly in separating manganese from iron, when the quantity of manganese is comparatively small. When however this is not the case, the precipitated oxyd of iron contains a considerable quantity of manganese which cannot be removed by boiling with the solution. The oxyd of iron must then without previous washing be dissolved in chlorhydric acid, again precipitated with ammonia, and the solution boiled till the free ammonia is expelled. It is also necessary in separating the bases by this process to bring the solution to the boiling point before adding ammonia, and to boil without intermission till all the free ammonia is expelled. In this manner, we avoid the formation of traces of sesquioxyd of manganese. When iron, manganese, alumina, lime and magnesia are present, and the quantity of magnesia is not too large, the solution may be saturated with chlorine, precipitated by ammonia, and the alumina, iron and manganese separated from the other bases by boiling with the solution. The manganese may then be separated from the alumina and iron by a precisely similar process.

Separation of Manganese from Magnesia and Lime.—This is best effected by adding acetate of soda to the solution, heating and passing a current of chlorine gas through it while hot. The purple red solution is to be supersaturated with ammonia and boiled till the free ammonia is expelled. The manganese is precipitated as sesquioxyd, while the magnesia remains in solution. When alumina and magnesia are present with the manganese, it is best to precipitate the alumina by carbonate of baryta, and then to separate the two other bases by the method already described. To separate manganese from lime, chlorine may be passed directly into the solution; ammonia is then to be added and the whole boiled as before. When alumina, manganese, lime and magnesia are present the dilute solution is to be oxydized by chlorine, and then the alumina and sesquioxyd of manganese precipitated by ammonia and the solution boiled till the free ammonia is expelled.

Separation of Strontia from Lime.—The best method of separating these bases, according to Rose, is the old process of Stromeyer, viz: by treating the nitrates with anhydrous alcohol, which dissolves the nitrate of lime. This process may be greatly improved by using a mixture of equal volumes of ether and alcohol. In this mixture the nitrate of lime easily dissolves, while the nitrate of strontia is almost absolutely insoluble.—*Pogg. Ann., No.* 6, 1860. W. G.

TECHNICAL CHEMISTRY.

9. *Test for Fusel Oil;* by W. STEIN.—Small bits of porous chlorid of calcium having been placed in a beaker glass, portions of the spirit which is to be tested are added until the mass is moistened to such an extent that it appears wet. The beaker is then covered with a glass plate and left to itself. If the spirit contains fusel oil, the odor of the latter may be detected after a while in the beaker, being still more strongly manifest, after the lapse of several hours. When only minute traces of fusel oil are present, one must allow the mixture to stand for a considerable time, before smelling of it.

According to Stein, this method is only a modification of the common test in which the spirit to be investigated is thrown into warm water. Since the impossibility of perceiving small portions of fusel oil in spirit depends upon the fact that the odor of this substance is masked by that of the alcohol vapor which is evolved at the same time, the formation of the latter must be prevented if one wishes to smell the fusel oil alone. This result may be attained either by diluting the alcohol with water, or better, as previously stated, by mixing with it an excess of chlorid of calcium, with which substance the alcohol combines so strongly, that its odor can no longer interfere with that of the fusel oil.—From *polytechnisches Centralblatt*, 1859, p. 1627; in Dingler's *polyt. Journal*, clv, 158.

10. *Value of different kinds of Soap;* by R. GRAEGER.—Complaints of consumers in regard to the value, or rather efficacy of samples of soap, which to the best of the manufacturer's knowledge, have been well prepared, are not uncommon.

It is very probable that the usual explanation which is offered, whenever a soap fails to fulfil the expectations of its consumer, viz: that it contains too much water, may be in many cases correct. Admitting this, and various other contingences, which are of importance in deciding upon the value of a soap, there appears to be another obvious reason why different soaps containing equal amounts of water may still possess different degrees of efficacy.

It is evident from the different equivalent weights of the various fatty acids, that the amounts of caustic alkali taken up by them in the formation of soap must be of unlike magnitude.

If it be true, that the detergent power of soap is entirely dependent upon the amount of alkali which it contains, of course it follows that those soaps which contain the largest proportion of alkali,—or in other words, those containing a fatty acid, the equivalent weight of which is small,—must be the most efficacious.

Since the difference between the equivalents of the common fatty acids are not large, these considerations are perhaps of little or no importance in so far as concerns the consumption of soap in household economy—the total amount used in a single family, being but small. In a manufacturing establishment, however, where fifty or a hundred thousand pounds of soap may be used, in the course of a year, differences which cannot be deemed insignificant, must exhibit themselves.

For example, the equivalent weights of several soaps, (regarded as anhydrous,) in common use, are as follows:

Oleic acid (red oil) soap,	-	-	-	= 3800·95
Palm oil	"	-	-	= 3588·85
Tallow	"	-	-	= 3300·95
Cocoanut oil	"	-	-	= 3065·45

Calculating from these weights how much of each of the other soaps would be required to replace 1000 pounds of tallow soap, the following quantities will be found:

1151 lbs. of Oleic acid soap, *i. e.*, 15·1 p. c. more than of tallow soap.
1087 " " Palm oil soap, *i. e.*, 8·7 " " "
928 " " Cocoanut oil soap, *i. e.*, 7·2 " less than "

Differences like these must certainly be of importance in practice; and could, doubtless, be detected by direct experiment, if any one would undertake a comparison of the various kinds of soap,—a research which would not be easy however.—*Bœttger's polytechnisches Notizblatt*, 1860, xv, 65.

11. *Pig-iron which contains Copper cannot be puddled;* by Dr. C. List.—It has been stated as a matter of belief among practical iron-workers in Germany, that pig-iron which contains copper cannot be puddled; assertions having even been made, that when one puddler wishes to annoy another he will sometimes throw a bit of copper—a small coin, for example, into the furnace, so that the iron cannot be made to "rise."

Without giving full credence, as yet, to this statement, Dr. List mentions that he has observed two instances, which go to prove that it may be correct. In the case which he has more particularly described, none of the phenomena which ordinarily occur, when iron is puddled, appeared. Some 400 lbs. of pig-iron having been placed in the furnace were melted in the course of half an hour,—at which time a sample taken from the molten mass was perfectly white, but the usual evolution of carbonic oxyd and consequent swelling, or "rising" up of the mass of scales, &c., about the iron, did not ensue. On the contrary, by the time that the balling together of the iron should have commenced, it was evident, that the charge could not be worked off; it was therefore removed from the furnace, after having remained there about three quarters of an hour. As the melted metal was flowing out, it emitted numerous beautiful blue sparks, which were also produced, when the metal in the furnace was stirred. The sparks were regarded by the workmen as an indication that the iron contained copper.

The amount of metallic iron, which remained, weighed 240 lbs., 160 lbs. having been lost in the scales and slag. Analyses [for details of which, see the original memoir,] were made of the original pig-iron, (I.); of the sample taken, as previously mentioned, from the melted iron, as it lay beneath the scales, (II.); and of the iron, after it had been removed from the furnace, (III).

	I.	II.	III.
Silicon, - - -	1·32	0·29	...
Sulphur, - - -	0·28	...	0·20
Manganese, - - -	3·56	...	0·48
Copper, - - -	0·35	0·38	0·57

It was evident, therefore, that the 400 lbs. of pig-iron used did really contain nearly a pound and a half of copper. It appears, moreover, that copper cannot be removed from iron by puddling. Calculating how much copper ought to be left in the iron which was finally removed from the furnace, in case none had been lost in the slag, it is found that there should be 0·58 per cent, almost exactly the quantity obtained in analysis No. 3.—*Dingler's polytechnisches Journal*, 1860, clv, 22.

F. H. S.

12. *Preparation of Oxyd of Lead free from Copper and Iron;* by TH. WICHMANN.—Of the many plans which have been proposed for utilizing the sulphate of lead which is formed in considerable quantity as a secondary product in the preparation of alumina mordants at print works, the method of reducing it in furnaces to the metallic state has been most frequently resorted to, since the quality of the lead thus prepared is of peculiar excellence. Instead of thus reducing the sulphate of lead, Wichmann proposes to convert it directly into oxyd of lead, maintaining that the oxyd thus prepared being uncontaminated with copper or iron will be well suited for the manufacture of white glaze for pottery—[probably also for making flint glass] it being somewhat difficult to obtain in commerce oxyd of lead which does not contain traces of these impurities. In his method, suggested by that of Mohr* for preparing caustic baryta, a quantity of caustic soda lye of from 28° to 30° (B.)= about 1·25 sp. gr., having been brought to boil in an iron kettle, the sulphate of lead is added to it little by little, with constant stirring, oxyd of lead and sulphate of soda being produced. The amount of sulphate of lead which shall be added to a kettle of soda, and which is somewhat less than the quantity which theory would indicate, must be determined once for all by direct experiment,† sulphate of lead being added until the sharp caustic taste of the soda is no longer manifest. It is well, however, to leave some free soda in the solution lest a portion of undecomposed sulphate of lead should contaminate the oxyd of lead which is formed, although a small amount of the latter will combine with the soda and remain in solution. During the boiling, the decomposition is rapid, and complete, unless the soda lye contained much carbonate of soda in which case a white scum of carbonate of lead will separate.

* To a boiling solution of caustic soda, of 1·10 to 1·15 sp. gr., of known strength an equivalent weight of powdered nitrate of baryta is added. As soon as the baryta salt has completely dissolved, the hot solution should be rapidly filtered in order to separate any sulphate or carbonate of baryta which may have been formed from impurities of the soda, and the filtrate set aside in a cool place. An abundant crop of crystals of hydrate of baryta soon forms. These crystals are to be drained from the solution of nitrate of soda, upon a funnel loosely plugged with cotton and the drying completed [according to Mohr] by means of a centrifugal machine. If required for purposes where the adhering nitrate of soda should be avoided the hydrate of baryta may be re-crystallized. In place of the nitrate of baryta one may use chlorid of barium—or in place of the soda, potash; but as a rule the presence of chlorine in the product would be more objectionable than that of nitric acid. On the small scale the process of boiling is best conducted in a glass flask, but where larger quantities are desired a covered iron kettle may be used—as in the common method of preparing caustic alkalies.—From *Archiv der Pharmacie*, lxxxviii, 38; in *Chemisches Centralblatt*, 1856, [N. F.,] i, 834.

[† For a ready method of obtaining the weight of moist sulphate of lead, see Mr. F. Mayer's paper in the March No. of this Journal, [2], xxix, 280.]

When the proper quantity of sulphate of lead has been added to the lye and the decomposition is finished, the contents of the kettle must be thrown into a vessel containing water in order that the sulphate of soda which has been formed may be retained in solution, which would not be the case if no water were added to the mixture. The oxyd of lead, which is in the form of exceedingly fine crystalline scales of a light yellowish red color* and of great purity, is readily deposited; after being thoroughly washed, to remove the sulphate of soda, it is dried and finally ignited in a reverberatory furnace—the charge being subsequently allowed to cool as slowly as possible.

As thus prepared the oxyd is an exceedingly soft powder of a yellowish red color like prepared litharge; it contains about 2 per cent of alumina which can not readily be removed, but which is not at all detrimental to its use in glazing pottery, and also a larger or smaller quantity of carbonate of lead according as the soda lye was more or less contaminated with carbonate of soda.

The crude sulphate of lead as it comes from the print works should be agitated and washed with water—or, better, forced through a fine seive in order to break up lumps and to remove any foreign substances,—before being used.

The residual solution of sulphate of soda being evaporated together with the first portions of the wash water, affords Glauber's salt containing alumina, plumbate of soda, acetate of soda (the acetic acid and alumina being both derived from the crude sulphate of lead), and chlorid of sodium (from the soda lye); being free from iron, it is suitable for glass maker's use.—From *Polytechnisches Centralblatt*, 1860, p. 411; in *Polyt. Notizblatt*, xv, 184.

13. *Cleansing of Mordanted Cloth before Dyeing;* by J. Lœwenthal. —It is well known that cotton cloth upon which alumina or iron mordants have been printed must be submitted to the so-called dunging process before it can be dyed.

The action of the ingredients used for dunging is:—1. to completely fix the mordants: 2. to remove the substance (starch, gum, &c.,) with which the mordant was thickened for printing; (3. as well as to remove the excess of mordant, and by combining with it prevent it from soiling those portions of the cloth which are to remain uncolored.—E. Kopp.)

Giving special prominence to the second of these desiderata, that of removing the thickening agent, Lœwenthal proposes to employ diastase, as contained in malt, in order to convert the starch into sugar thus rendering it readily soluble so that it can be easily removed from the cloth.

By direct experiment he has satisfied himself that the addition of malt to baths of bran (previously boiled) or of cowdung, is decidedly beneficial; cloths which have been printed with an alumina mordant thickened with starch being very rapidly cleansed in this manner. With iron mordants a somewhat longer time is required than with those of alumina but they are nevertheless cleaned much more rapidly than when no malt is used.

A temperature of 35° to 40° R. [=111° to 122° F.] is sufficient that the malt shall act powerfully.

* If a more concentrated soda lye be used, say of 40° B., somewhat larger crystals of a dark red color are formed.

When the dunging bath contained water glass (sesquisilicate of soda) the use of malt gave rise to the formation of spots upon the cloth in the process of dyeing. The author thinks, however, that this objection might perhaps be obviated if purer diastase were used instead of malt.

In this connection Barreswil remarks that he has employed pepsine with success in removing colors fixed with albumen.—*From Journal für praktische Chemie*, lxxix, 480; *in Répertoire de Chimie Appliquée*, ii, 168.

14. *Incineration of Filters.*—The great difficulty with which in many cases, the last portions of the carbon of a filter are consumed when ignited in a porcelain crucible is a fact well known to analysts. It does not appear, however, that the following simple method of obviating the difficulty—as practised in the laboratory of Prof. Scheerer in Freiberg—has ever received the publicity which it deserves.

Whenever a filter upon which a substance capable of injuring platinum has been collected is to be incinerated, the porcelain crucible or capsule in which the process is to be conducted should be placed *within a vessel of platinum* of similar form, and the whole ignited in the usual way.

Whether the greatly accelerated rapidity of combustion of the carbon, which ensues depends upon a more equable distribution of heat brought about by the greater conducting power of the metal,—an explanation which is current for the somewhat analogous case of copper-coated glass flasks, or whether as seems probable, the power of the porcelain vessel to absorb heat be really increased by the interposition of the platinum; whether both these causes be of influence, or the result depend upon another less apparent reason; or finally whether vessels of some other metal would not be preferable to those of platinum; are questions which we do not propose to discuss in this connection. We desire only to give currency to the *fact* to which attention has been called, feeling assured that the chemist who has once employed this method to destroy a refractory filter will ever afterwards bear it in mind. F. H. S.

15. *On the occurrence of the Hydrocarbon* C_4H_2 *in Coal Gas.*—In describing the explosive red compound* which he obtained by passing a current of street gas through an ammoniacal solution of dichlorid of copper, Bœttger (*Ann. Ch. u. Pharm.*, cix, 353), called attention to the fact that an abundant evolution of gas ensues when the compound is treated with moderately concentrated chlorhydric acid. This gas has recently been more carefully examined by Berthelot (*Comptes Rendus*, l, 805), who finds its composition to be C_4H_2, and calls it *acetylene*, or quadricarbide of hydrogen. It is evidently the prototype of a series of hydrocarbons, the general formula of which is $C_{2n}H_{2n-2}$. According to Berthelot, acetylene is formed whenever olefiant gas, or the vapor of alcohol, ether, aldehyd, or of wood-spirit is passed through a red hot tube.

* This explosive compound has also been described by Quet, (*Comptes Rendus*, 1858, xlvi, 905), who obtained it when the gas prepared by decomposing alcohol by a series of electric sparks was treated with an ammoniacal solution of dichlorid of copper. It was observed in 1839,—long before the experiments of the chemists above mentioned, by Prof. Torrey of New York, on the occasion of its occurrence in the copper service pipes at that time in use for distributing gas. (See *American Gas-Light Journal*, Oct. 1859; *Répertoire de Chimie Appliquée*, i, 493; compare Bœttger's *Notizblatt*, 1860, xv, 117), (note).

It is formed also when the vapor of chloroform is brought in contact with red hot copper; and is moreover a constituent part of illuminating gas. Of the foregoing sources, ether furnishes it in the greatest abundance. In whichever of these methods the gas may have been prepared, however, it is always mixed with a large quantity of other gases, from which it must be separated in the manner indicated by Bœttger before it can be obtained in a state of purity.

Acetylene is a colorless gas, somewhat readily soluble in water, having a disagreeable and characteristic odor, and burning with a very luminous and smoky flame. Its sp. gr.=0·92; it has not been liquified either by cold or pressure. Mixed with chlorine it detonates almost immediately even in diffused day light, carbon being deposited. When exploded in the eudiometer 1 volume of acetylene consumes 2·5 vols. of oxygen and forms 2 vols. of carbonic acid. Its formula represents 4 volumes of vapor.

In general the properties of this gas are similar to those of olefiant gas (C_4H_4); and by combining with bromine, sulphuric acid, the elements of water, and with hydrogen, it forms compounds parallel to those formed in similar cases by olefiant gas.

[In a technological point of view this gas is of great interest; for not only is Berthelot's observation of the first importance in itself as a contribution to the chemistry of gas lighting, but further investigation of the subject will no doubt lead to the elucidation of several of the vexed questions upon which gas engineers are at variance. For example, the fact that a quantity of useful gas—probably much more luminous than an equal bulk of olefiant gas, is produced when the latter is strongly heated, must be a most acceptable support to those who advocate "high temperatures" as the best system of gas making;—as it must also materially modify, the prevailing notion that the luminiferous properties of olefiant gas are entirely destroyed by such treatment. In a word, those who from theoretical premises have satisfied themselves that the employment of "high temperatures" in gas making is pernicious, and have therefore opposed this system, must reconsider their argument.*

Again, the knowledge that a luminiferous gas so readily soluble as acetylene occurs in coal gas is a subject most worthy the consideration of those gas engineers who advocate the use of much water in the purification,—or who, in the terse language of the opponents of their system, "would 'scrub' the life out of the gas!"

The occurrence of acetylene, and no doubt of some of its homologues, in illuminating gas is moreover another evidence of the error, still frequently fallen into by chemical writers, of attributing all the luminif-

* We would in no wise affirm either that the researches of Berthelot and Bœttger have demonstrated the excellence of the system of high temperatures, or that it would be advantageous in practice to decompose olefiant gas for the sake of the resulting acetylene, nor would we in any way imply that the constantly increasing growth of this system is due to the good quality of the gas produced,—for this last is in many instances most certainly not the case; the rise and progress of the system abroad having been mainly due to a most unhealthy competition among rival gas companies. We urge only that the system of high temperatures contains one favorable element which had hitherto been overlooked by chemists. F. H. S.

erous power of coal gas to the olefiant gas, and homologues of the series $C_{2n}H_{2n}$, contained in it. The incorrectness of which view has been shown by Frankland, (*Ann. Ch. u. Pharm.*, lxxiv, 57. See also lxxxii, 1), by Lewis Thompson (Ure's *Dictionary of Arts*, &c., 4th edit., Boston, 1853, i, 438), and by others, and has been recognized, we believe, by every chemist who has latterly made a special study of the technology of gas making.

Berthelot promises soon to publish the results of his examination of the compounds which acetylene forms with chlorid of copper and with nitrate of silver* and of mercury, and of the analogous compounds which the last two salts form with olefiant gas. He also alludes to a method of isolating olefiant gas, the publication of which can hardly fail to interest gas makers.

It is to be hoped that in the same connection M. Berthelot will make some slight allusion to the labors of Edmund Davy, (*Annalen der Pharmacie*, xxiii, 144; from the *Records of General Science*, Nov. 1836, through *Journal de Pharmacie*, *Mars.*, 1837, p. 143), who obtained from the decomposition by water of the brown mass—"carbide of potassium"—which occurs in the preparation of potassium from burnt tartar and charcoal, a gas† of the same composition (C_4H_2) and of identical properties with that which forms the subject of this notice.

Besides this, the observations of Courbe, (*Annales de Chimie et de Physique*, 1838, (2,) lxix, 184: compare Gmelin's Hand Book, x, 411, and xi, 395), should be remembered. In a liquid which was deposited by illuminating gas (from rosin) when this was subjected to pressure, Courbe detected compounds, (for example, "B"$=C_{10}H_8$, and "F"$=C_{12}H_{10}$), which accord with the general formula of the acetylene series, and which in view of their origin would seem to be entitled to a place therein, at least until their right to the position shall have been disproved. So also, perhaps, with the campholene ($C_{18}H_{16}$) of Delalande, (*Ann. Ch. et Phys.*, [3], i, 125).

While the labors of these chemists do not in the least degree detract from the intrinsic value of Berthelot's observations, they should nevertheless neither be lost sight of nor passed over in silence]. F. H. S.

16. *Action of Carbonate of Soda on Cast-Iron.*—In July, 1857, C. Tissier, director of the Aluminium Works at Amfreville, published in the *Technologiste*, (p. 357), some interesting experiments on this subject, an abstract of which we now make from Dingler's Polytechnisches Journal, cxlvi, 118, (1857). Tissier's attention was first drawn to the fact that the mixture of carbonate of soda, chalk, and charcoal used in the manufacture of sodium, notwithstanding the great excess of carbon it contains—does not affect the malleability of the iron of the retorts which are employed. He found further, when a piece of *cast iron* was submitted to a high temperature, with this mixture, that it was first converted into *steel*,

* Compare Bœttger, *loc. cit.*, also Vogel and Reischauer, in Kopp and Will's Jahresbericht der Chemie, für 1858, p. 208.

† This gas was called klumene by Leopold Gmelin, in his Hand Book (Cavendish Soc. Ed., viii, 150).

and finally into *malleable iron.* This led him to try the effect of the action of carbonate of soda alone on both malleable and cast iron—malleable iron thus treated, remained unchanged, while the soda salt extracted the carbon and silicium from the cast iron, thereby converting it into infusible malleable iron.

If a specimen of pig-iron (that experimented on contained 6·6 pr. ct. of silicium and free carbon) be exposed for several hours at a red heat in a crucible containing an excess of carbonate of soda, the following reactions may be observed: As soon as the temperature is sufficiently elevated the mass commences to rise and large bubbles of carbonic oxyd are given off, burning with a yellow flame. If after the evolution of carbonic oxyd has ceased, the fire is allowed to go down and the iron taken out with tongs, and freed from adhering salts by means of a hammer and by water, the metal exhibits a completely etched surface, although the form of the mass is unaltered—it may be drawn out under the hammer and forged either hot or cold, and the granular fracture of the cast iron is replaced by a fibrous crystalline texture—the mass is porous, the little cavities being filled with white silicate of soda, formed from the silicium contained in the metal. The iron thus obtained is scarcely attacked at all by chlorhydric acid in the cold, and but slowly even when heated. Dilute nitric acid acts upon it with energy, but still not so rapidly as in the case of ordinary malleable or cast iron.

Tissier considers it conceivable that this action of carbonate of soda not only extracts the carbon and silicium but also must remove the phosphorus and sulphur contained in the iron. It is further possible that the iron takes up a portion of sodium, which does not injure it, but on the contrary the metal acquires desirable properties as evinced by the fact of the dealers being very willing to purchase the worn out retorts from the sodium works. If sodium be not thus taken up, we must assume that for every equivalent of carbonic oxyd an equivalent amount of anhydrous soda is formed. Tissier suggests that in the process of annealing or the conversion of cast iron into malleable iron, now accomplished by packing and heating for a long period with substances rich in oxyd of iron, it may be possible to substitute fusion with carbonate of soda, it possessing the advantage that the metal can be removed from time to time to watch the progress of the conversion into *steel* or *malleable iron.*

The author hoped by this method to convert large masses of cast-iron into malleable metal, such as heretofore could only be obtained by forging, but the length of time required for the conversion of a mass of any considerable thickness and the porosity of the iron obtained, present practical difficulties requiring some modification to overcome them. With smaller castings, however, the action, even when superficial, imparts to them great toughness so that they no longer are liable to fracture. The amount of carbonate of soda required, when properly used, is inconsiderable, but it should be pure, or if the commercial article be used, it must first be heated with carbon in order to reduce the sulphate of soda to sulphid of sodium, as the alkaline sulphates have a powerful action on iron at a red-heat.

II. GEOLOGY.

1. *Geological Survey of Canada.—Report of Progress for* 1858. Montreal, 1859, 8vo, pp. 263, with 4 Maps and Sections.—In the present volume Sir William Logan continues his description of the distribution of the rocks of the Laurentian series. These stratified rocks, the oldest not only of America but probably of the world, have long been regarded by the officers of the Geological Survey of Canada, as identical with the oldest crystalline rocks of Scandinavia and Scotland; and Sir Roderick Murchison in his late admirable investigations of the geology of his native Highlands has recognized the parallelism, and adopted the name of Laurentian for the oldest Scottish rocks, which he had formerly designated as *fundamental gneiss*. Laurentia is destined to be a domain second only in importance to Siluria, embracing, as it does, in Canada, a mass of strata probably equal in amount to the whole palæozoic series in its greatest development, and including not less than three limestone formations, the most considerable of which is 1000 feet in thickness. These are associated with gneiss, quartzite with garnets, and great beds of rock made up of triclinic feldspars, (labradorite, or andesine,) often with hypersthene or pyroxene. Argillites appear to be wanting throughout the system. The whole of this great series of sediments is profoundly altered, yet the existence in the limestones of forms resembling *Stromatocerium*, not less than the presence of beds of graphite, iron-oxyd and metallic sulphurets, points to the probable existence of life during the deposition of these most ancient strata. (This Journal, [2], xxx, 134.)

Intrusive rocks are not generally met with in the Laurentian series, but in the vicinity of Grenville, there are injections of syenite, orthophyre, and dolerite, making four distinct periods of eruption, of which three at least were anterior to the deposition of the lowest Silurian strata.

The difficulties attendant upon the investigation of a disturbed region like that presented by the Laurentian rocks in Canada or in Northern New York, are enhanced, by the fact that it is still to a very great extent covered by primeval forests. The outcrop of the limestones, however, is generally marked by valleys, well watered and with a fertile soil which has invited settlers to some distance from the frontier of the region, and the result of two years of investigation has enabled Sir William to trace out the distribution of these limestone bands through the counties of Ottawa and Argenteuil, including fifty miles of the valley of the river Rouge; from the map of this exploration, which accompanies the Report, we may get an idea of the complexity of structure in this region. After some new observations upon the great beds of magnetite belonging to this series, and the veins of galena, which cut alike the Laurentian strata and those of the Calciferous sandrock, the report goes on to describe the copper deposits of the Eastern Townships of Canada. These occur in strata which overlie the Hudson River shales, and are named the Quebec group. The copper occurs both in the altered and unaltered strata, and is found alike in dolomites, steatites, argillites and silicious chloritoid slates, generally disseminated in the beds, but frequently in veins of quartz and bitter spar, and more rarely with specular iron and native gold. The copper itself is rarely native, generally occurs as erubescite, copper glance or copper pyrites. The famous Acton mine is a deposit between dolomites

and shales, and forms apparently a lenticular mass. It is a conglomerate of which the sulphurets of copper form the cement, and encloses rounded and angular fragments of calcareous and silicious rock. Similar conglomerates, but much less rich in copper, occur in other localities in the same region.

Mr. Alexander Murray makes a report upon the Thessalon and Mississauga rivers, giving the results of his topographical examinations, and contributing farther information as to the structure of the Huronian rocks, which upon Lake Huron attain a thickness of about 10,000 feet and are intercalated between the Laurentian and Lower Silurian series. They are made up of quartzites with two great bands of slate conglomerates, and masses of interstratified diorites, besides two or more bands of limestone, whose distribution has been most serviceable in making out the structure of the region. The copper of the Bruce and Wellington mines, of Root River and Echo Lake occurs chiefly in veins cutting the diorites of this series, although the metal is also found disseminated in some of the beds. Mr. Murray has considered the disturbances of this series of rocks with particular reference to the distribution of the copper veins, and has given us a section, together with a map showing the distribution of the Huronian limestones. A remarkable dislocation occurs in the valley of the Thessalon, bringing the Laurentian gneiss in contact with the upper portion of the Huronian series by a vertical displacement of 9,200 feet.

The results obtained by Mr. J. Richardson in an examination of a part of the district of Gaspé are next given, with a map showing the distribution of the rocks. The Shickshock mountains, which are a continuation of the Notre Dame and Green Mountains have a synclinal form: and appear as a mass of crystalline schists in great part epidotic, quartzose and chloritic, running about E.N.E. for a distance of sixty-five miles and rising in points to about 3700 feet. Along their northern base the slates and conglomerates of the Quebec group, are seen dipping southward, but around their southern slope, repose the Devonian rocks. Associated with these crystalline schists are great masses of serpentine, which at Mt. Albert are seen sweeping around the base of the hills. A remarkable section here exhibits a synclinal form with an overturn dip on the south side, so that the serpentines, which are really beneath the epidotic and hornblendic and chloritic rocks, seem to overlie them. That portion of the serpentine which succeeds to the black hornblende slate is beautifully and distinctly stratified. The weathered surfaces exhibit opaque white or fawn colored bands of from one-eighth of an inch to an inch in breadth, with thinner red partings. Within, the rock is dark brown or greenish, with deep red bands, sometimes including grains of chromic iron and diallage, as well as thin layers of asbestus. The thickness of this stratified portion is about 400 feet; it is succeeded by about 600 feet of dark green serpentine, which is not distinctly stratified, and reposes directly upon black slates and limestones. The facts already published by the Canadian Survey have shown that it is impossible to regard the great masses of serpentine so common both in the Laurentian and Silurian series, as anything other than sedimentary deposits, and we think it indeed a question whether serpentine ever takes the form of an intrusive rock. (See further on this subject Mr. T. Sterry Hunt, in the Report for 1853–56, pp. 432 and 480, and this Journal, [2] xxv, 217, xxvi, 234.)

In the present Report Mr. Hunt gives the results of a series of investigations upon the intrusive rocks of the vicinity of Montreal. These include orthophyres, some of which are very beautiful porphyries, and a great variety of trachytic rocks, passing into granites on the one hand and to phonolites on the other, besides diorites, augite rock and dolerites, some of them containing large portions of olivine. These investigations include a great many analyses of the rocks and their component minerals, and are followed by the continuation of Mr. Hunt's researches on the formation of magnesian rocks. With this investigation our readers have already been made acquainted. (See this Journal, [2], xxviii, 170, 365, xxix, 285.)

By way of Appendix to this Report, we have a catalogue of the plants and animals collected in the counties of Argenteuil and Ottawa by Mr. W. M. S. D'Urban, an accomplished young naturalist now at the Cape of Good Hope, who accompanied Sir William Logan during the summer of 1858—and made as complete a collection as possible of the flora and fauna of the district. A similar collection was made in the Lower St. Lawrence and in the district of Gaspé by Mr. Robert Bell, an assistant of Mr. Richardson. The species were determined in part by Mr. B., and part by Mr. D'Urban, Drs. Dawson, Le Conte, Lea and Mr. Binney. The collection of marine animals, obtained in part by dredging, is considerable, and an important contribution to the fauna of that region. T. S. H.

2. *Geological Surveys.*—Kentucky.—The fourth volume of this Survey now in press contains the stratigraphy and palæontology of all the coalfields of Kentucky excepting a few of the southeastern counties. It is provided with five plates and a great number of comparative sections, illustrative of the general distribution of the coal measures.

Arkansas.—The second volume of this Survey contains a geological description of all the counties not treated of in the first report. Mr. Lesquereux contributes to this volume the palæontological and stratigraphical descriptions of the coalfields of the State—a comparison of botanical distribution with the geological formations—and a catalogue of the phenogamous plants of Arkansas with short descriptions of the plants useful in agriculture, medicine, &c. This catalogue contains Nuttall's plants with those found by the Survey. The Palæontology is illustrated by six plates.

Illinois.—We have elsewhere stated, (p. 125,) some of the results of this State survey under the able direction of Mr. Worthen—the publication of this very valuable Report now awaits only the needful appropriation of money which a State so intelligent and prosperous as Illinois, cannot withhold—for a work which will be at once so useful and so honorable to her enlightened liberality.

Texas.—We hear with great regret that the able Director of this Survey has been removed from his post to make way for another person—without the means of judging of the circumstances of the case, we know too well Dr. Shumard's ability to discharge his duties, to suppose that Science will gain by the change—which we have reason to fear has been brought about by means of personal influence with the Governor of the State aided by the power of some influential scientific names.

California.—Prof. Whitney whose departure for his post of duty we noticed in our last—has reached San Francisco with all his party and outfit without loss or delay—and was making preparations to enter at once on the active duties of his post.

CANADA.—The results of the labors of Sir William Logan and his able corps of associates—as far as they have been made public are noticed on page 122.

It is plain to all who take an interest in the progress of geology in the United States, that an active discussion is now imminent on the questions touching Barrande's primordial zone. In this discussion the 'Taconic System' of Emmons so long suppressed, will probably be again put forward. Already the contestants are sharpening their weapons, and we will not anticipate the discussion farther than to intimate that the views of the distinguished French geologist will find a warm opposition at the hands of the New York State Palæontologist, and probably also with some of the gentlemen of the Canadian Survey. The subject is already before the Boston Society of Natural History, where Mr. Marcou appears as the advocate of the Taconic System. This geologist finds evidence of the existence of the primordial fauna not only in the metamorphic black slates of Georgia in Vermont, but at the Falls of Montmorency, in the region between the Upper Mississippi and Lake Superior, near Lake Michigan, on the north shore of Lake Superior near the Pic, in the Black Hills of Nebraska, and in Texas.

NEW YORK.—Prof. Hall's third volume (text) on the Palæontology of New York, so long looked for, has been in print for some time, but has been held back to ensure completeness under the important genus Eurypterus. It is now before us, and we are assured by him that it will be speedily distributed. The Introduction handles with masterly skill the difficult subjects connected with the proper classification of the lower horizons of life in our planet. A review of this important chapter with reference to the views of Barrande will probably appear in our next. The plates for this volume are not yet all ready for delivery.

3. *Descriptions of new species of Crinoidea and Echinoidea from the Carboniferous rocks of Illinois, and other Western States;* by F. B. MEEK and A. H. WORTHEN, of the Illinois State Geological Survey, pp. 19. Proceed. Acad. Nat. Sci., Pa., Sept., 1860.—This paper contains descriptions of twenty-nine new species. *Platycrinus*, 3 species, *Dichocrinus*, 4; *Trematocrinus*, 1; *Actinocrinus*, 6; *Forbesiocrinus*, 2; *Zeacrinus*, 3; *Cyathocrinus*, 5; *Poteriocrinus*, 2; *Archæocidaris*, 1; *Palæchinus*, 1; *Melonites*, 1. It is suggested by the authors that the genus *Trematocrinus* of Hall is identical with *Goniasteroidocrinus* of Lyon and Casseday. If so, the latter genus will have to take precedence, from priority of publication. H.

4. *Descriptions of New Carboniferous Fossils from Illinois and other Western States;* by F. B. MEEK and A. H. WORTHEN, of the Illinois State Geological Survey, pp. 26. Proc. Acad. Nat. Sci., Pa. Read Oct. 23d, and published Nov. 24th, 1860.—This interesting paper comprises 69 species, all of which are supposed by the authors, to have been heretofore undescribed. They may be enumerated as follows: *Ephenopterium*, 4 species: *Palasterina*, subgenus *Schænaster*, 1; *Chonetes*, 1; *Productus*, 3; *Rhynconella*, 1; *Athyris*, 1; *Pecten*, 1; *Aviculopecten*, 7; *Avicula*, 1; *Myalina*, 3; *Solemya*, 1; *Leda*, 1; *Schizodus*, 1; *Cardiomorpha*, 1; *Bellerophon*, 1; *Pleurotomaria*, 11; *Euomphalus*, 2; *Naticopsis*, 2; *Platyostoma*, 2; *Eunema*, 1; *Loxonema*, 5; *Eulima*, 1;

Macrocheilus, 3; *Soleniscus*, 1; *Orthoceras*, 1; *Cyrtoceras*, 2; *Nautilus*, 7; *Goniatites*, 3.

The authors have established a remarkable new genus of Zoöphytes, *Sphenopoterium*, from σφην, a wedge; ποτηριον, a cup.

"This small group of corals appears to be more nearly related to *Cyathoceris*, of Edwards and Haime, than to any other genus, either recent or fossil, with which we are acquainted. It differs, however, in having the outer walls perforated, and in being destitute of distinct rays, as well as in the peculiar wedge-like form of the base of the corallum, which is also usually, if not always, free instead of attached."

The authors also describe a new genus of Gasteropoda, *Soleniscus*, to include certain species allied to *Loxonema* and *Macrocheilus*. The illustrations with more extended descriptions will appear in the forthcoming report of the Illinois Survey, which promises to be one of unusual interest. Besides the numerous invertebrate fossils, it will contain illustrations and descriptions of over one hundred new species of fossil fishes of Dr. J. S. Newberry; a report on the Bryozoa of Dr. H. A. Prout; a report on Fossil Plants of Mr. Lesquereux and a report on the Lead region of Illinois by Prof. J. D. Whitney. H.

5. *Systematic Catalogue, with Synonyma, &c., of Jurassic, Cretaceous and Tertiary Fossils collected in Nebraska, by the Exploring Expeditions under the command of Lieut. G. K. Warren*, of U. S. Topographical Engineers; by F. B. Meek and F. V. Hayden.—Of the 276 species and varieties enumerated in the following catalogue, 25 are from Jurassic rocks, 194 from Cretaceous, and the remaining 57 from Tertiary strata. None of the Jurassic species are known to occur in this country east of the Black Hills, or south of the middle of eastern Utah, though some of them will probably be found in New Mexico. One species is believed to be identical with *Ostrea calceola* of Roemer from the Jurassic rocks of Germany, and another (*Ammonites cordiformis*) is probably not distinct from *A. cordatus*, Sowerby, which occurs in the Jurassic series of England, France, Russia, &c. Nearly all the other Jurassic species mentioned in the list are closely allied to forms common in the lower part of that system (the Lower Oolite and Lias) in the old world, and several of them may prove identical on farther comparison.

Of the 194 Cretaceous species the following seven are common to the Nebraska and New Jersey beds, viz.—*Nautilus Dekayi*, *Ammonites placenta*, *A. complexus**, *A. lobatus**, *Scaphites Conradi*, *Baculites ovatus*, and *Gryphæa vesicularis?*; and the following five species are probably common to Nebraska and foreign localities, viz.—*Nautilus Dekayi*, *Inoceramus problematicus*, *Gryphæa vesicularis*, *Cucullæa fibrosa*, and *Micorbacia coranula*.

The 57 Tertiary species are believed to be all distinct from foreign forms, and none of them have yet been found in this country east of Nebraska, or south of northeastern Utah. They are all, so far as known, extinct species."

The Palæontological portion of Lt. Warren's report is now completed, containing extended discriptions and comparisons of over three hundred species of fossils, from all the formations known in the northwest. The illustrations comprise over one thousand figures of Mollusca and occupy forty-five quarto plates.

6. *Observations on the Cretaceous Strata of Texas;* by B. F. Shumard, M.D., (Trans. Acad. Sci. St. Louis, vol. i, No. 4, p. 582).—The leading points in Shumard's paper bearing upon the disputed geology of the southwest are these. First he recognizes at the base of the Cretaceous series of that region, what he calls the Arenaceous group, and places it on a parallel with our No. 1, of Nebraska, (Miocene of Marcou and Prof. Heer). This is as was shown by Messrs. Meek and Hayden in 1857* a part of Marcou's Jurassic and Triassic of the *Pyramid Mountain Section.* It is also the horizon of their Cretaceous leaves of Nebraska and Kansas as Shumard states, and he finds great numbers of Cretaceous fossils in it, though no leaves.

Above this he finds other beds which he places on a parallel with No. 2 and 3, of the Nebraska section, and shows that they are the horizon occupied by Marcou's *Ostrea Marshii* and *Gryphæa dilatata,*† upon which he rests his claims to the discovery of the Jurassic of the southwest.

These beds Meek and Hayden had also placed on a parallel with No. 2 and 3, of the Nebraska section, as Shumard states. Thus as is seen, all explorers concur in the opinion that what Marcou calls Jurassic, at least, at the localities where he found fossils, is Cretaceous. There doubtless are Jurassic and Triassic rocks in New Mexico, and possibly in parts of Texas, but all the fossils Marcou relied upon to prove it, are Cretaceous species, as already stated. And the Jurassic and Triassic of his section, at the main localities cited, are Cretaceous beds. Shumard's paper is an important one, and when we consider his opportunity to understand these matters in making State explorations, is entitled to great weight. M.

7. *Die Silurische Fauna des westlichen Tennessee;* 4to. pp. 97; three lithographic and two copper plates; by Dr. Ferdinand Roemer; Breslau, 1860.—In this work Dr. Roemer has noticed and figured 58 species of fossils from the Upper Silurian rocks of Tennessee. Of these he identifies 22 as occurring in the Niagara group of the State of New York, and 28 in Europe, in the Wenlock formation of England and in the limestones of the Scandinavian Islands, Gothland and Malmö. The most interesting are those which he has described as fossil sponges under the genera *Astylospongia Palæomanon* and *Astræospongia.* The specimens are spheroidal sub-cylindrical or cyathiform like the sponges of the cretaceous and Jura formations. They are silicified and in the polished sections, numerous radiating canals with star-like groups of spiculæ are clearly exhibited, presenting an internal structure altogether analagous to that of the more recent sponges. There are six species described, one of which, *Astylospongia præmorsa* is identified with the European *Siphonia proæmorsa* (Goldfuss). Fossil sponges are rare in all the formations below the Cretaceous and Jura, but we have some reason to believe that they here occur at the very base of the palæozoic system. In addition to the American species described by Dr. Roemer we find that another form has been discovered in the lower Silurian rocks of Kentucky for which the name *Scyphia dentata* has been proposed. (See the 2d Report of the Geo. Sur., of Kentucky, page 111.) In Canada a species closely allied to Roemer's *A. stellatim-sulcata,* oc-

* Proceed. Acad. Nat. Sci., Phila., May, 1857, p. 133.

† As we had also shown in Proceed. Acad. Nat. Sci., May, 1857, p. 133.

curs in the Trenton Limestone while two or three others have been found in the Chazy and Calciferous formations. These will be described soon in the Reports of the Geological Survey of Canada. One of the Canadian species somewhat resembles in form the *Palæotrochus* of Emmons. (See this Journal, 2d Series, vol. xxii, p. 389), and has one of the extremities covered with radiating grooves in the same manner. It seems probable therefore that *Palæotrochus* is a sponge instead of a coral. Dr. Roemer has described two new genera of Crinoids, *Lampterocrinus* and *Cytocrinus*, both of which appear to be related to *Actinocrinus*. Among the brachiopods, we find *Calceola Tennesseensis*, no doubt, identical with Prof. Saffords *C. Americana* published in this Journal in March last; the former name has the priority as Roemer has described it several years since in Bronn's Lethea Geognostica. The concluding chapter contains an interesting comparison of the Upper Silurian Fauna of Tennessee with that of the same age in Europe. All the species are well figured.

E. B.

[We have received, too late for this issue, an important paper from Prof. Safford "On the Upper Silurian beds of Western Tennessee, and Dr. Roemer's Monograph." A principal point in this paper is to indicate the fact that the fauna illustrated by Dr. R. is not the only one occurring on the 'glades.' To illustrate his subject Prof. Safford brings forward for the first time a tabular section of the order of succession and thickness of the rocks of the Upper Silurian in Tennessee. This memoir will appear in the succeeding number of this Journal.—Eds.]

III. BOTANY AND ZOOLOGY.

1. *Thesaurus Capensis, or Illustrations of the South African Flora, etc.*, by Wm. H. Harvey, M.D., F.R.S., &c.—No. 4, 1860, completes a century of plates and the first volume of this work. The plates are neatly executed and much better printed than those of the earlier numbers. The most interesting one to us is that of a Loasaceous plant, *Fissenia Capensis*, which is geographically very widely severed from all its coördinates, and has a trilocular ovary. A. G.

2. *Flora Capensis; being a Systematic Description of the Plants of the Cape Colony, Caffraria, and Port Natal;* by Wm. H. Harvey, M.D., F.R.S., &c., and Otto Wilhelm Sonder, Ph. D., &c., vol. I, Ranunculaceæ to Connaraceæ, Dublin, 1859–60.—An octavo volume of 546 pages, the first of the "at least five volumes" required for the completion of the Cape Flora. The second volume is in progress. Being intended for use in the Colony as well as by botanists generally, the work is written in the English language throughout. In view of this popular use, a comprehensive and excellent Introduction to Systematic Botany is prefixed, taken, with some alterations and additions, and by permission, from that in Mr. Bentham's Handbook of the British Flora; and to this is joined a set of clear and specific directions for the collection, preservation, and examination of plants. The sequence of orders adopted in the Flora is essentially that of DeCandolle. As one of the authors resides in Dublin, and the other in Hamburgh, the only course to take—and in any case the wiser course—was "to divide the work between them, each taking those Orders with which he was most familiar, and making them

out independently, without reference to his brother author;" although, to ensure uniformity of plan, the ordinal characters and general remarks are all written by Dr. Harvey, upon whom the general editorship devolves. The descriptions are pretty full, so that only about three species appear on a page. The great knowledge and ability of the distinguished authors, and their long familiarity with Cape plants, guarantee the high character of the work, as their untiring industry and perseverance gives good hope of their bringing to a worthy and timely completion the formidable task they have undertaken. Noting that Dr. Sonder has adopted Dr. Klotzsh's genus *Dianthera*, in the Capparideæ, we beg to say that there is a Linnæan genus of that name, unaccountably neglected by recent botanists (North American ones excepted), but not rightfully to be superseded. A. G.

3. *Flora of the British West Indian Islands;* by A. H. R. Grisebach, M.D., Professor of Botany in the University of Göttingen. London: Lovell Reeve. Parts 1 and 2, 1859, pp. 192, 8vo.—This is another of those Colonial Floras now fostered by the British Government; indeed this is the first strictly belonging to the series. It is written throughout in English, and wonderfully good English too, considering that the author is a German. Through abbreviations and the omission of references, it is more compact than the Flora Capensis, and will probably be comprised in one or two volumes. The work is much needed, and Dr. Grisebach is doing excellent service in clearing up the manifold confusion and obscurities of West Indian Botany, and indeed of Central American Botany generally, to which he has paid much attention. The third part of this work, completing the Polypetalæ and Apetalæ combined, is, we learn, already published.

[The third part of the West Indian Flora has just come to hand. It finishes the Poly-apetalous orders, and closes the first volume of 322 pages. The larger orders it comprises are the *Leguminosæ*, the *Myrtaceæ*, and the *Melastomaceæ*, the two latter are very thoroughly and admirably re-elaborated.]

Another Flora of this series, now printing, is that of the island of Hong Kong, by Mr. Bentham. Among the most important materials for this Flora must be reckoned the collections made in that island by Mr. Charles Wright, as Botanist of the North Pacific Expedition under the command of Captains Ringgold and Rodgers, which are liberally contributed for this purpose. The same Expedition contributes also to the Flora Capensis "upwards of five hundred species of plants" from the collection of the same indefatigable botanist made whilst the vessels were detained in Simon's Bay; among which, adds Dr. Harvey, are some species not received from other collectors,—good evidence of Mr. Wright's industry and acuteness.

These qualities, and an indomitable spirit of research, are now applied to the West Indian flora; and the fruits are beginning to appear in the

4. *Plantæ Wrightianæ e Cuba Orientali*, a A. Grisebach;—a paper in the Memoirs of the American Academy of Arts and Sciences, vol. viii, new series, of which a small edition is separately issued for distribution among botanists. It contains many new and rare species, and the field is far from being exhausted. This paper is followed by

5. *Filices Wrightianæ et Fendlerianæ*, etc., cura DANIEL C. EATON, A.M., an enumeration of the Ferns of this same rich Cuban collection, along with those of Fendler's Venezuelan collection, with characters of new species, etc. The sets of Fendler's Ferns issued to subscribers are exhausted; but those of Wright are still to be had, and are to be augmented by new collections. A. G.

6. *Local Botanical Catalogues.*—These are interesting as helping to determine the geographical range of our species, and also as indicating the zeal and activity of our local botanists, perhaps never greater than now. The following, published during the year 1860, are before us:—

7. *Additions to the Flora of Wisconsin;* by T. J. HALE, of the University of Wisconsin.—The number of species and varieties added to Mr. Lapham's latest Catalogue, published in 1852, "amounts to 283, of which 112 are Mosses, Liverworts, and Lichenes." The catalogue of these is contributed by Mr. Lapham. The most notable addition is that of the rare *Sullivantia Ohionis*, before known at only one station, in the central part of Ohio, but lately detected by Mr. Lapham on the Wisconsin River.

8. *Catalogue of the Flowering Plants and Ferns of Ohio;* by J. S. NEWBERRY, M.D. Originally prepared for the Ohio State Medical Society, but now published by the Agricultural Society, prefaced by some interesting remarks upon the influences, "physical, geological and climatic, which have determined the distribution of the species.

9. *A Catalogue of Plants found in New Bedford, Mass., and its vicinity;* by E. W. HERVEY. The plants are arranged according to the season of their flowering. Nine species only come into bloom between the middle of March and the first of April,—viz., the common Chickweed, the English Groundsel, which are introduced, two Poplars, two Hazels, and an Alder, *Epigæa*, and *Draba verna*. We suspect that the latter is also an introduced plant.

10. *Catalogue of the Phænogamous and Filicoid Plants of New Castle County, Delaware, arranged according to the Natural System, with the Synonyms of Modern Authors;* by EDWARD TATNALL. (Published by the Wilmington Institute.)—A very full and handsome Catalogue of 112 pages, including a list of expected species, and an extended catalogue of the *Diatomaceæ* and *Desmideæ* detected in that district, by Mr. C. Febiger. The addenda comprises among other things, the *Sagittaria calycina* of Engelmann. This was known only as a Western species, viz. —in Texas, Louisiana and Missouri. In the manuscript, communicated by Dr. Engelmann to the Botany of the Mexican Boundary Survey, he gave the "Merrimac River, Missouri," as a station of one variety of this species. In the proof-reading this was somehow changed into the better known "Merrimac River, Massachusetts." This error proves to be less serious than could have been expected, Mr. Swan having since detected a submerged form of this very distinct species at Kennebunk, Maine, not far north of the Merrimac. Mr. Tatnall has now found it in Delaware. A. G.

11. *Fungi Caroliniani Exsiccati: Fungi of Carolina illustrated by natural specimens of the Species;* by H. W. RAVENEL, Corresp. Memb. Acad. Nat. Sciences, &c. Fasc. I–V. Charleston, S. C., Russell & Jones,

King st.—These fascicles are volumes, of quarto form, each containing a century of species; the specimens attached to the leaves of thick cartridge paper, with printed tickets. Each volume has an Index, and the fifth, issued last autumn, has a full index of the whole work. This induces the fear that the undertaking may not be continued farther. Much as this is to be regretted it is not surprising; for these undertakings involve a deal of labor and anxiety. The Cryptogamic *Exsiccati* of this country—as a whole perhaps unrivalled by those of any other—viz., of the *Musci* by Sullivant and Lesquereux, the *Lichenes* by Tuckermann, and the *Fungi* by Ravenel,—are all labors of love, and monuments of patience and disinterestedness; for their cost to subscribers defrays but a moiety of the cost of production. They are intended to stimulate research in these several branches of Cryptogamic Botany, and to facilitate their study. For this last purpose these *Exsiccati* are all essential, and they would be hardly less so even if proper manuals and other descriptive and illustrated works upon our lower Cryptogamia were generally obtainable. In time these desiderata will probably be supplied; but authentic specimens will always be invaluable. The former volumes of Mr. Ravenel's *Fungi* have been noticed and commended in this Journal. The fifth century is equally interesting and full. Perhaps the proof-reading of the letter-press, or the niceties of the typography have not been so heedfully attended to as could be desired; but we must not be over nice or too critical. We are truly grateful for what Mr. Ravenel has done, and hope that his strength and patience will still hold out through as many more centuries of *Fungi Caroliniani*. A. G.

12. *Uber Polyembryonie und Keimung von Cœlebogyne: ein Nachtrag zu der Abhandlung über Parthenogenesis bei Pflanzen, von* A. Braun. (Aus. Abhandl. der K. Akad. Wissenschaft. Berlin, 1859.) Berlin, 1860.—This elaborate treatise On the Multiplicity of Embryos and Germination of *Cœlebogyne*, a sequel to the Memoir on Parthenogenesis in Plants, occupies 263 quarto pages, and is illustrated by six plates. It discusses in great detail not only polyembryony, but many recondite incidental questions arising out of parthenogenesis. The principal direct, and a very curious contribution to our knowledge is, that polyembryony is common, or even general, in parthenogenesis; in other words, when embryos are produced without impregnation, they are apt to be superfluously and abnormally numerous. Thus, the seeds of *Ardisia polytoca*, figured by Prof. Braun, are stuck as full of embryos as is a pudding with plums. It would be interesting to know whether, conversely, multiplicity of embryos as it occurs in this case, and in orange seeds, where the flowers are hermaphrodite, indicates, not superfluous impregnation, but failure of impregnation,—a singular paradox. A. G.

13. *Illustrations of the Genus Carex;* by Francis Boott, M.D., Treasurer of the Linnæan Society. Part Second, Tab. 201–310. London, Wm. Pamplin, 1860, folio.—Two years ago we gave some account of the first volume of this magnificent and munificent work. We now have before us a second volume, containing one hundred and ten more plates, of an execution more uniformly excellent than before. The species illustrated are considerably less numerous than the plates, for sometimes two or three, or even four, and in two instances five folio plates are de-

voted to the various forms of one species. American Caricologists will be delighted to find so many of our own species in this volume, such as *C. Franklinii*, *laxa*, *livida*, *limosa*, *Magellanica*, (which is *C. irrigua*,—here we think the rule of priority might have been waived), *rosea*, *retroflexa*, *bromoides*, *glaucescens*, *turgescens*, *Elliottii*, *Schweinitzii*, *rostrata*, *folliculata*, *subulata*, *Shortiana*, *debilis*, *glabra* (a new species gleaned from our old fields by Dr. Kneiskern), *retrorsa*, *tentaculata*, *Halei*, *squarrosa-stenolepis*, *Novæ-Angliæ*, *Emmonsii*, *varia*, *Pennsylvanica*, *umbellata*, *nigremarginita*, *Floridana*, *Richardsoni*, *miliacea*,—not to mention several others from further north or the far northwest. We hear that even a third volume is in a forward state of preparation, which may be laid before our Caricologists by the time they have digested the ample portion now so liberally supplied,—so rich is our author in materials, so zealous in good works. "*Carice pastus acuta*" having long foraged upon the sedges of every land, and ruminated his vast stock of materials with unwearied patience and skill, long may he still flourish to produce such noble volumes as these. A. G.

14. *A Second Century of Ferns; being Figures with brief Descriptions of one hundred new, or rare, or imperfectly known species of Ferns; from various parts of the World;* by Sir William Jackson Hooker, K.H., &c. London, 1860. William Pamplin. 8vo. Parts I and II, tab. 1–50.—The first Century of Ferns was published several years since; it consisted entirely of plates and descriptions taken from the well known *Icones Plantarum*, but the plates were not numbered to correspond with those of the *Icones*, and for this reason the work has not been generally quoted by writers on Ferns. The second *Century*, however, consists entirely of new matter, well selected, and its publication brings to light many new or obscure species. A new *Struthiopteris* (*S. orientalis*, Hook.) from Japan, figured at plate 4, and the imperfectly known *Camptosorus Sibiricus*, Rupr., (here reduced to *Scolopendrium*,) at plate 35, will especially interest the American botanist. The latter Fern differs from our common Walking-leaf "by the entire absence of lobes or auricles at the base of the frond." D. C. E.

15. *Species Filicum; being Descriptions of all known Ferns. Illustrated with Plates;* by Sir William Jackson Hooker, K.H., &c. Parts XI and XII, or vol. iii, parts III and IV. pp. 161–291, tab. 181–210.—This portion of the work is mostly taken up by the latter part of the great genus *Asplenium*, including *Darea*, *Athyrium*, *Diplazium*, *Anisogonium*, *Hemidictyum*, &c., of authors. *Diplazium* differs from other *Asplenia* only in the double fruit-dots, a most inconstant character. *Darea* passes into *Euasplenium* through many species having the marks of both groups; and even *Athyrium*, perhaps the best defined of all, is too uncertain to be separately retained. Such genera as *Anisogonium*, *Hemidictyum* and *Thamnopteris*, depending only on slight differences in venation, are of course rejected, in conformity with the plan of the whole work. Of the genus, thus consolidated, 305 species are described, besides many dubious or unknown forms, which are barely enumerated. The graceful little Fern from Florida, distributed by Dr. Chapman under the names of *Aspl. Anchorita*, *A. verecundum*, &c., and which in his Flora is called *Aspl. myriophyllum*, Presl., is here reduced to *Aspl. rhizo-*

phyllum, Kunze, var. *myriophyllum*. It is undoubtedly through some mistake that Milwaukee in Wisconsin is given as a station for it. *Allantodia Brunoniana*, Wall., of the East Indies, and *Actiniopteris radiata*, Link., of a wider range, follows next to *Asplenium*. The usual Index concludes the volume. The distinguished author is now arranging the Aspidioid Ferns, which, we trust, will in due time appear in the fourth volume. D. C. E.

16. *Uber einige Farngattungen;* von Dr. G. METTENIUS, Professor an der Universität zu Leipzig. Frankfort-on-Main. Heinr. Ludw. Bronner. 1857–9, 3 vols. 4to.—The first contribution (I.) contains an essay of sixteen pages on the classification of Ferns, which being in German is not accessible to the majority of those whom it would naturally interest and doubtless enlighten. The learned author carefully considers the subject of the venation of Ferns, and after studying it more deeply, perhaps, than any other Pteridologist, considers that while differences of venation are of great use in distinguishing species and sub-genera, they are too indefinite to be used as generic characters. This essay is followed by a monograph of the genus *Polypodium*, in 121 pages, in which 268 species are recognized, many of them described and illustrated by references to the numbers of distributed collections, and often by fragmentary but careful sketches of the venation, in three crowded lithographic plates. There are also given the names of a hundred or more dubious or imperfectly known species. In the index the names of not less than fifty genera of various authors are given as synonymous with parts of *Polypodium*. The species are classified mainly according to the venation and the shape of the fronds; and the whole arrangement is so simple, and yet so comprehensive, that, after a little studying of the meaning and application of the words used to distinguish sub-generic groups, one has but little difficulty in tracing an unknown species to its appropriate place in the vast genus.

The second part (pp. 158, tab. 4,) contains (II.) a monograph of *Plagiogyria*, a new genus of six species, (since reduced to *Lomaria* by Hooker,) (III.) a notice and figure of *Pteris scalaris*, Moritz, from Venezuela, showing a double involucre, similar to that known to exist in *Pt. aquilina* and its allies, and (IV.) an able monograph of *Phegopteris* and *Aspidium*, treating these genera in the same way as *Polypodium* in the first article. Of *Aspidium* there are given forty-seven generic synonyms, excluding such universally adopted genera as *Asplenium*, *Polypodium*, *Woodsia*, &c., to which some species have been incorrectly referred. The admitted species number two hundred and thirty, and there are perhaps half as many more doubtful ones.

The third part (pp. 210, tab 6,) treats in a similar way of (V.) *Cheilanthes*, and (VI.) *Asplenium*, two hundred and forty-nine species of the latter genus being recognized.

In this series of useful and comprehensive treatises "on certain Fern-genera," Professor Mettenius has followed out logically and carefully the principles he laid down at the beginning, and consequently, whatever views of the importance of venation, etc., botanists may have, all must concede to his writings a consistency as well as ability not often met with. In the identification of species Professor Mettenius has to aid him the large and

valuable herbarium of Kunze, his predecessor at Leipzic, and has been intrusted with numerous collections from various herbaria, embracing the original specimens of various authors, as Swartz, Desvaux, Presl, &c. To these may be added many of the Ferns collected by Wilkes' Exploring Expedition, so that he will be able to identify in his future works the species described by Brackenridge in the report on the Ferns of that Expedition. D. C. E.

17. *Filices Horti Botanici Lipsiensis;* G. METTENIUS. Lips., 1856. fol. pp. 135, tab. 30.—In this work, which preceded those above-mentioned, Professor Mettenius has had an opportunity of applying his principles of classification to the whole class of Vascular Cryptogamia. *Phegopteris*, though without an indusium, is retained as a genus among the *Aspidieæ* because the stipe is continuous with the rhizoma, and not articulated as in *Polypodieæ*, and because the habit, which has nothing in common with *Polypodium* so closely resembles that of many *Aspidia*, that botanists are continually making interchanges between the two genera, as the species become better known. *Hypolepis* is regarded as *Phegopteris* with reflexed lobes, and is therefore put next to it. The suppression of the old Linnæan genus *Hemionitis* will be regretted, but its venation is all it has to distinguish it from *Gymnogramme*, to which it is here reduced. The *Acrosticheæ* of course give Professor Mettenius some trouble, and it is doubtful if he can eventually limit them to the five genera recognized in this work.

The book is beautifully printed, and the plates are of singular accuracy and distinctness. D. C. E.

ZOOLOGICAL NOTICES.—

18. *On the genus Peasia.*—In the Proceedings of the Zoological Society of London for 1860, page 37, plate 70, Mr. Wm. H. Pease of Honolulu has published descriptions and colored figures of five species of Planariidæ from the Sandwich Islands, supposed to form a new genus. Of these species, which are pretty well represented on the plate, the first is a *Stylochus*, the second and fifth are *Prosthiostoma*, the third a *Physanozoum*, and the fourth an *Eurylepta*. This kind of progress can scarcely benefit science. As well might one take a *Strombus*, a *Conus*, a *Cypræa* and a *Terebra*, and found upon them a new genus of shells! W. S.

19. *On the genus Bipaliura;* by WM. STIMPSON.—During the visit of the North Pacific Expedition to Hong Kong in 1854, my attention was called, by Dr. Bowring, to some remarkable vermiform animals which he had observed creeping among damp dead leaves in his garden, and which he called "ground leeches." One of these we fortunately secured, which was found upon examination to possess the following characters. The body was linear, nearly two feet in length when fully extended, and scarcely more than an eighth of an inch in breadth. The surface was slimy, like that of a slug, and of a greyish color, with two or three longitudinal black stripes above. The head was lunate, transverse to the body, with the convexity in front, and the auricles projecting laterally to a distance equalling about half the width of the body. Upon the upper surface of the head, were scattered some minute black specks, which were undoubtedly imperfect eyes (ocelli). On the inferior surface of the body there were two small apertures in the median line, the anterior one of which, at the middle of the body, was the mouth.

The worm therefore belonged to the order Turbellaria and to the tribe of Planarians, it is undoubtedly one of the most remarkable forms, of a very distinct and peculiar genus. Upon a recent examination of the literary history of the group I find that species of the genus have been seen and described by several other observers. The following is its history.

Many years ago (1835) Dr. T. E. Gray in his "Zoological Miscellany" first described one of these animals under the name of *Planaria lunata*, from Bengal, (Zool. Misc. p. 5). The description is short, but sufficient to show unmistakably the place of the species in the genus under consideration. This description has been overlooked by all subsequent authors, and even Dr. Gray himself appears to have forgotten it, although he has undoubted priority.

In 1842 Dr. Cantor in a paper on the fauna and flora of Chusan (Ann. Mag. Nat. Hist., ix, 277) says, "Among the annelides occurs a remarkable form with the anterior part drawn out to the sides like the head of *Zygæna*. He also speaks of two other species known to him, one from Bengal. The latter is probably *Pl. lunata*.

I can find no further published mention of such forms, even in the "Systema Helminthura" of Diesing, 1851, who overlooks Gray's description,—until the appearance of my Conspectus of the Turbellaria Dendrocœla in the Proceedings of the Philadelphia Academy of Natural Sciences for February, 1857, where the genus is described under the name of *Bipalium*, which name was suggested by the resemblance of the animal, in the shape of its head, etc, to a double mattock, or pick-axe. It was placed in the family *Geoplanidæ* with the following diagnosis.

"Corpus lineare, depressiusculum. Caput discretum, lunatum, transversum; auriculis sat longis, retrorsum tendentibus. Ocelli numerosi, minuti, in capite plerumque in ejus marginibus dispositi. Os centrale vel post-centrale. Apertura genitalis inter os et extremitatem posteriorem, sepius ad dimidiam distantiæ sita."

Four species were described, all from the Japanese islands. The original species observed in China was not found named in the Synopsis, as the specimens of that species were unfortunately lost.

In 1859 the genus was renamed by Dr. Schmarda in his "Neue Wirbellose Thiere." He calls it Sphyrocephalus and gives a colored figure, and an anatomical description.

Still more recently, in the Annals and Magazine of Natural History, it has been again named by Dr. E. Percival Wright, who calls it *Dunlopea*, and describes three species. Dr. Wright, however, having only preserved specimens to examine, has misunderstood its character somewhat. He states that there are no ocelli, and has failed to perceive the genital opening.

Both Schmarda and Wright have overlooked previous labors, so that the genus now rejoices in three distinct appellations, all given within four years. Of these *Bipalium* is the earliest. Eight species are now known.

20. *The Museum of Comparative Zoölogy* in Cambridge, Mass., was dedicated with appropriate ceremonies and addresses, to the service of Science and the Commonwealth, on the 13th of November, in the presence of a large concourse of invited guests.

IV. ASTRONOMY AND METEOROLOGY.

1. *Three more Asteroids.*—Three more of the large group of little planets between Mars and Jupiter have been discovered since Sept. 1, 1860. In consequence of a prior discovery, the one detected by Mr. Ferguson at Washington, D. C., September, 1860, and numbered 59, has been advanced to No. 60. It is proposed to call it *Titania.*

The numbering of the asteroids is in danger of becoming confused on any plan yet devised. It is scarcely possible to say what is the order of discovery in absolute time, for a planet is sometimes seen several days before its true character is determined. The exact order of numbering is of little importance, but it is desirable that the numbers once adopted should not be changed without urgent reason. The number of the second Daphne is not even yet well settled.

The 59th asteroid, (of 10th magnitude) was discovered by M. Chacornac at Paris, Sept. 12, 1860.

The 61st, named *Danäe*, (of 10–11th magnitude) was first seen Sept. 9, 1860, by Goldschmidt, but on account of his illness it was lost for several days.

The 62d named *Erato* (of 11th magnitude) was discovered by Drs. Förster and Lesser at Berlin, Sept. 14, 1860.

2. *New Comet.*—A telescopic comet was discovered October 23, 1860, by M. Temple at Marseilles. Its place, Oct. 23, $16^h\ 30^m$ m. t. Mars., was R. A. $10^h\ 4^m\ 38^s$, N. decl. 28° 27′.

3. *Further observations on the Shooting Stars of August* 9–10, 1860.

(1.) *At Chicago, Ill.*, by Mr. Francis Bradley and others.

On the evening of August 8, 1860, Mr. B. watching alone from $10^h\ 30^m$ to midnight, saw *seven* shooting stars, but the sky was much clouded.

On the night of Aug. 9 he observed alone from $11^h\ 30^m$ P. M. to 1^h A. M. of the 10th, *fifty-seven* shooting stars, 41 of which he counted during the last hour, the sky being throughout the hour much encumbered by small cumulous clouds.

On the night of Aug. 10, Mr. Bradley was assisted by Messrs. E. P. Marsh, Wm. Dickinson, Henry E. Chesbrough, and I. H. Scupham. Between 11^h P. M. of the 10th and 2^h A. M. of the 11th, they observed 384 different shooting stars, distributed as follows, viz:

11h to 12h		12h to 1h		1h to 2h	
N.E.	23	N.E.	23	NE.	15
E.	40	E.	31	E.	19
S.	26	S.	35	S.	15
S.W.	32	S.W.	35	S.W.	24
N.W.	22	N.W.	22	N.W.	22
	143		146		95

During the last hour clouds appeared and increased so much that by 2 o'clock the sky was half covered, and the watch was therefore given up. After midnight the moon also interfered to some extent. Of the whole number of meteors seen about 30 were not conformable to the usual radiant, which for the night of the 10th–11th was a circle about two degrees in diameter, whose centre was in A.R. $2^h\ 8^m$, N. P.D. 29°.

The Aurora Borealis was visible Aug. 8, 10, 12, 17, being uncommonly fine on the night of the 10th–11th.

(2.) *Paris, France*, by M. COULVIER-GRAVIER.—This indefatigable observer has published in the Comptes Rendus of the French Academy (li, 263), a table giving the results of his observations from July 13 to Aug. 12, 1860. The mean hourly number at midnight of shooting stars Aug. 9 he finds to be 62, Aug. 10th, 54, or about ten times as large as he finds it in the middle of July.

(3.) *Rome, Italy*, by M. SECCHI.—The shooting stars observed early in the month gave a decisive maximum on the 10th of August, viz.,

9th, from	9h		to	10h 30m	P. M.	50	shooting stars,	of which	8	were	very	brilliant.
10th, "	8h 45m	"	10h 30m	"	124	"	"	"	25	"	"	"
11th, "	8h 30m	"	9h 30m	"	25	"	"	"	5	"	"	"

The observations at Chicago of the 10th–11th, taken with those at New Haven of the night before, show that the August meteoric display continues to agree closely in all its characteristics with the phenomenon as observed more than twenty years ago. The number of shooting stars at this epoch is at least six times the common average, increases from evening twilight to morning dawn, is about equal on the night of the 9th and the night of the 10th, and the apparent direction of nearly all is from the vicinity of the constellation Perseus. E. C. HERRICK.

4. *Shooting Stars in November*, 1860.—For a few years before and after the ever-memorable meteoric showers of November 13th, 1832, and November 13, 1833, shooting stars were unusually abundant on that calendar day. The cycle of this phenomenon being apparently about thirty-three years, there is reason to hope for its recurrence on a large scale in 1865, 1866, or 1867, and we may expect now to see some traces of its coming. At New Haven this year, the sky was unfortunately overcast during the nights of Nov. 11–12 and 12–13. The following statements show, however, that about this period the number of shooting stars was plainly above the average. The observations from Maryland indicate that, notwithstanding this is leap-year, the night of the 13th–14th is the most fertile. This confirms the supposition that the meteoric shower of November is slowly advancing into the year. If, as is highly probable, this display is the direct successor of the like displays of Oct. 26, 1202 and Oct. 30, 1366, (this Jour. [1], xl, 364,) the motion of the node of the zone or ring which furnishes these shooting stars is at the rate of three or four days in a century. E. C. H.

(1.) *Near Cape Hatteras*, lat. 35° N., long. 75°, Nov. 7, 1860.—Dr. Bronson, of New York, Prof. C. U. Shepard and daughter, counted *forty-six* meteors in two hours, from 7^h to 9^h P. M. They were mostly from a point to the N.E. of the zenith. The mate of the steamer Columbia said he saw an equal number the previous night when they were North of Cape Hatteras. The night of the 8th nothing unusual was seen.

(2.) *New Haven, Conn.*—Wedn. morning, Nov. 14, 1860. Sky very clear and no moon. Prof. H. A. Newton, watching alone, from 3^h 15^m to 4^h 15^m and looking to the S.E. observed *twenty-one* shooting stars. His view was limited by high buildings and other obstructions, and embraced about one fourth of the hemisphere, from the zenith down to an altitude of about 30°; the constellation Leo being in the centre of the field of view. Of the meteors seen less than a fourth part traced back would intersect in the sickle in Leo, a larger number would intersect near the zenith. None were remarkable for size or for train.

Nov. 15. Sky very clear. Prof. H. A. Newton watching as before, during 45 minutes from $3^h\ 40^m$ to $4^h\ 25^m$, observed *fifteen* shooting stars, having the same general characteristics as those of the morning previous.

(3.) *New York City.*—November 14. Prof. A. C. Twining watched for shooting stars during one hour, from 3 A. M. to 4 A. M. His position was at an open area commanding a good view of the S. E. quarter of the sky. The atmosphere was uncommonly clear, but the glare of the street lamps doubtless interfered with the visibility of very faint meteors. During the first fifteen minutes by estimate, he observed ten meteors, eight of which had paths conformable to the radiant point of 1833, and two of which had paths not conformable. For the next half hour not a meteor was seen. At $3^h\ 45^m$ the largest of all appeared, with a long, conformable and brilliant path. After this till 4^h three non-conformable were seen, two of which shot from near the zenith. The observed number during the hour, was therefore 14, nine conformable and five unconformable. In conclusion, he remarks:—"Compared with the similar phenomena in the years following the great meteoric shower of 1833, the meteors of the present year (except the single one at $3^h\ 45^m$) were but faintly developed. Yet it was impossible not to perceive in the whole taken together at least a *symptomatic* return of the periodical display. The morning of the 13th may have been richer in the phenomena, but it was not favorable for observation."

(4.) *Montgomery Co., Md.*—Very full observations were made during the two entire nights of Nov. 12 and 13, (both clear,) under the direction of Mr. Francis Miller, principally by the students of the Stanmore School, in Montgomery Co., Md. The following table shows the number of shooting stars observed during the different hours.

		N.	S.	E.	W.	
Nov. 12,	6½ P. M. to 7 P. M.	0	1	3	0	4
	7 " 8	5	8	5	3	21
	8 " 9	9	12	6	3	30
	9 " 10	11	9	13	5	38
	10 " 11	8	12	14	4	38
	11 " 12	12	14	13	6	45
			N.W.	E.	S.W.	
13,	0 A. M. " 1 A. M.		13	20	9	42
	1 " 2		10	13	6	29
	2 " 3		25	30	13	68
	3 " 4		19	23	18	60
	4 " 5		16	20	12	48
						423
		N.	S.	E.	W.	
13,	6½ P. M. " 7 P. M.	4	3	8	6	21
	7 " 8	13	6	14	9	42
	8 " 9	8	7	13	2	30
	9 " 10	6	5	12	7	30
	10 " 11	10	8	19	7	44
	11 " 12	7	6	12	13	38
14,	0 A. M. " 1 A. M.	11	9	13	13	46
	1 " 2	25	18	20	20	83
	2 " 3	8	24	20	10	62
	3 " 4	7	17	12	10	46
	4 " 5	16	16	11	15	58
		115	119	154	112	500

For the purpose of comparison, Mr. Miller with some of his scholars observed on the night of December 12, 1860, and during 3 hours and 40 minutes ending at midnight, they saw 180 different shooting stars, distributed as follows, viz:

	N.	S.	E.	W.	
8h 20m to 9h P. M.	13	8	5	4	30
9 " 10	13	8	4	9	34
10 " 11	10	30	7	9	56
11 " 12	16	15	21	8	60

It should be remembered that the season from December 6th onward a few days is one in which shooting stars are sometimes unusually numerous. (See this Jour. [1], xxxv, 361.)

(5.) *Bloomington, Ind.*—In a letter to the Editors of this Journal, Prof. Daniel Kirkwood of the Indiana State University writes as follows: "Assisted by several members of the Senior Class, I kept an incessant watch for meteors during six hours on the night of the 12th inst. (November, 1860.) The number of observers was at no time less than five, so that the entire hemisphere was kept in view. The first to notice the appearance of a meteor announced it aloud, that it might not be counted more than once. The whole number seen was 381, as follows:

From 10h to 11h P. M.	45
11 " 12	66
12 " 1	68
1 " 2	66
2 " 3	90
3 " 4	46
	381

About one half of those seen after one o'clock appeared to diverge from the usual point in Leo."

5. *Narrative of the American Expedition to N. W. British America, to observe the total Solar Eclipse of July 18th*, 1860; written by Wm. Ferrel, and communicated by Capt. C. H. Davis, U. S. N., Superintendent of the Nautical Almanac.—The party consisted of two assistants sent from the Nautical Almanac Office, and of Mr. S. H. Scudder, of Boston, who was sent by the Museum of Comparative Zoology to make collections in Natural History, and who was also engaged to assist in making observations on the day of the eclipse. Leaving Boston and Cambridge at different times, the members of the party met at St. Paul on the 14th of June. Engaging a passage here on Mr. Burbank's line of stages and steamboat for Fort Garry, on the Red river of the north, they left on the morning of the 16th, and after traveling four days in a northwestern direction over the beautiful and fertile, though almost entirely uninhabited, plains of Minnesota, they arrived at Georgetown, on Red river. The party remained here one day waiting for the arrival of the Anson Northrop, a boat which runs on the Red river between this place and Fort Garry, and while here, enjoyed the hospitality and kind assistance of A. H. Murray, Esqr., Chief Trader of the Hon. Hudson's Bay Company, who seemed to be much interested in science in general, and in the success of the expedition. After following the very tortuous course of Red river about 400 miles, the party arrived at Fort Garry, in British America, on the 25th of June. Calling here upon Gov. Wm.

Mactavish, and presenting him a letter received from the late Sir George Simpson granting permission to enter the territory, the members of the party were treated by him very courteously, and received his efficient and kind advice and assistance in obtaining an outfit and supplies for their canoe voyage through lake Winnipeg and up the Saskatchewan river. He made arrangements to transport them and their baggage on a barge to the Stone Fort about twenty miles below Fort Garry, and granted them the use of a large North canoe there without charge, and also gave them a letter to Mr. Lillie in charge there, requesting him to aid them in obtaining a suitable crew, and every thing else necessary for the expedition. An old and experienced guide and five paddlers were obtained, mostly aboriginal natives of the country, and the party was ready to leave on the 28th. The remainder of the route of the expedition was down the Red river about twenty miles to the lake, through the lake to the mouth of the Saskatchewan, and then up the Saskatchewan to Cumberland House, in all about 550 miles. The country after leaving the Red river settlement, is a desolate and uninhabited wilderness, abounding in marshes and tamarac swamps, with a few limestone bluffs along the western coast of the lake. A few encampments of migratory Indians, obtaining a miserable subsistence from fishing, were the only inhabitants seen. A voyage on lake Winnipeg in a frail canoe of birch bark, when it is stormy, is considered dangerous, especially the making of traverses of ten or twelve miles, of which there are a great many, and as the party had an unusually stormy time, and a rather frail canoe heavily loaded, it was very much detained on the voyage by the wind and waves. The party was fourteen days in going the length of the lake from Red river to the mouth of the Saskatchewan, and during the whole time it was enabled to proceed only one entire day without interruption, and was obliged to spend three consecutive days and nights on a small island in the lake on account of a long continued and violent storm. On arriving at the mouth of the Saskatchewan it was found that the river was never known to be higher, and that the ascent over the rapids and up the current the whole distance to Cumberland House would be unusually difficult only a little more than four days were left; yet the party still hoped to be able to accomplish it against the time of the eclipse. The crew labored very hard in ascending the rapids, being obliged at some places to drag the canoe along close by the shore by means of ropes, taking first only one half of the baggage and then returning for the other half, and at other places to exert the utmost of their strength with long poles in getting it past high and steep bluffs and rocks projecting into the current, so that two days were spent in making the Grand Portage, and ascending some eight or ten miles of rapids near the mouth of the river. The party now despaired of being able to reach Cumberland House in time for the eclipse, but still had hopes of being able to get within the limits of total darkness. After passing through Cedar lake, the whole country for nearly a hundred miles was overflowed by the water of the river, so that the party could find no dry spot to stop upon but were obliged to cook with a fire made amongst the roots of large floating trees, and eat and sleep in the canoe. In order to get, if possible, within the limits of total darkness to ob-

serve the eclipse, the crew were persuaded to paddle up the river for thirty-six hours without stopping for sleep or rest, but late in the evening preceding the eclipse the party had been able to get only to the mouth of Moose river, a few miles only within the limits of total darkness. It was now very cloudy and rainy, and the strength of the crew was exhausted so that the party could do no better than stop and make preparations for observing the eclipse from this point, if by chance it should be visible next morning. It was, however, still raining in the morning and continued very cloudy until after the beginning of the eclipse, so that it could not be observed. A few glimpses of the eclipse were caught nevertheless, before it became total, but for some time immediately before and after the time of totality it was completely obscured by the clouds, so that no observations of the physical phenomena which always occur at that time, could be made. Just before the time of the total eclipse the clouds suddenly became very dark, which any one not acquainted with the cause might have attributed to the sudden gathering and thickening of the clouds before a heavy shower of rain. The darkness was at no time so great that the title page of the Nautical Almanac could not be read with facility. The instant of the end of the total eclipse was determined by the observation of a sudden change in the intensity of the light, although the disc of the sun was not seen for some time afterward. There were two strata of clouds, an upper stratum with openings through which the disc of the sun was at times seen, and a lower stratum of thin scudding clouds, which served as a screen during the greater part of the time, for observing the eclipse when it was seen through the openings in the stratum above.

The following are the results of the observations made with the telescope and sextant:

Latitude of station, - - -	53°	45′	46″
Chronometer fast of local time, - -	1^h	54^m	14·1
Ending of total eclipse, - - -	18	20	53·9
Last contact, - - - - - -	19	21	9·1
Last contact with large spot, - -	19	7	29·1

The party was furnished with Professor Hind's Report, and the accompanying maps, of the Assinaboine and Saskatchewan exploring expedition, which were of great advantage in enabling it to determine its rate of progress, the distance and locality of good boat harbors, &c., by a reference to the map in which all the principal bays, islands, capes, harbors, dangerous boulders, &c., seem to be accurately delineated, as well as described in the report. They were especially useful in determining the point on the river of the southern limit of total darkness of the eclipse.

In returning, the party was again much detained by stormy weather, being obliged to stop four days and nights on point Kichinashi, and was again fourteen days in traversing the lake. On arriving at Fort Garry, on the 8th of August, it was found that the Anson Northrop had stopped running on account of low water and was laid up for the season, so that the party was detained there two weeks without any means of getting away or writing home. Finally an arrangement was made with Mr. M'Kinney, who was coming through to St. Paul with

a train of ox wagons and carts for merchandize, to take the party and its baggage with him: hence its long delay. Twenty-two days were occupied in crossing the plains from Fort Garry to St. Paul, by way of Pembina on Red river and Crow Wing on the Mississippi, 130 miles above St. Paul, so that the party were not able to get back to Cambridge before the 20th of September.

V. BOOK NOTICES.

1. *On the Impurities of Commercial Zinc, with Special Reference to the Residue insoluble in Dilute Acids, to Sulphur, and to Arsenic;* by CHARLES W. ELIOT and FRANK H. STORER. pp. 40, 4to. (From the Memoirs of the American Academy of Arts and Sciences, [N. S.,] vol. viii, p. 57).*

In the elaborate memoir before us the authors have given a detailed account of their investigation of the impurities of commercial zinc and of their endeavors to obtain precise and definite knowledge upon the subject, with which to replace the loose, inaccurate and often contradictory statements which are current in chemical literature.

Having in the first place given a very complete synopsis of the opinions which had previously been recorded, they proceed at once to describe the experiments made by themselves. In order that their results should be as general as possible they examined authentic specimens of all the commercial zincs which they were able to procure: viz., 1. *Silesian*, 2. *Vieille Montagne*, 3. *New Jersey*, 4. *Pennsylvanian*, (from Penn. and Lehigh Zinc Works at Bethlehem,) 5. *Vieille Montagne*, (such as is used at the U. S. Mint,) 6. a sample labelled *Zinc pur*, from Rousseau Frères dealers in pure chemicals at Paris, 7. of unknown origin obtained in Berlin, (Prussia),—8, 9, 10 and 11, samples of "*English* Zinc," obtained from different works in Wales.

"A qualitative examination of the residues left by these zincs when treated with dilute acids, showed that they consisted chiefly of *metallic lead*. It will appear in the sequel, that lead is the chief impurity of commercial zinc, and that the carbon, tin, copper, iron, arsenic, and other impurities found in it by previous observers, occur either in very minute quantities, or rarely, and doubtless accidentally."

The amount of lead in each of the zincs above specified was determined quantitatively with great care. The results are as follows:†

Name of Zinc.	Amount of lead in per cent.
Silesian,	1·46
Vieille Montagne,	0·292
New Jersey,	0·079
Pennsylvania,	0·000‡
Mint,	0·494
Rousseau Frères,	0·106
Berlin,	1·297

* Communicated to the Academy, May, 29th, 1860.

† For the methods of analysis followed and precautions taken, as well as for numerous other interesting details which lack of space compels us to omit, the reader is referred to the original memoir.—EDS.

‡ This zinc leaves no appreciable residue when dissolved in dilute acid.

Name of Zinc.		Amount of lead in per cent.
English	from Wrexham, - - -	1·192
	" Mines Royal (Neath), - - -	0·823
	" Dillwyn & Co. (Swansea), - -	1·661
	" Messrs. Vivian, (") - -	1·516

Minute traces of *cadmium* and of *tin* were observed in several of the samples of zinc. In no case however could the sum of both these metals have amounted to one twenty-fifth of one per cent,—excepting the New Jersey Zinc which gave decided indications of tin.

No *copper* could be detected in any sample of zinc excepting that from New Jersey which contained 0·1298 per cent of this metal.

That *iron* is usually present in commercial zinc—in quantity generally less than 0·2 per cent—being derived from the moulds in which the zinc is cast, has been demonstrated by previous observers.*

Messrs. Eliot and Storer have therefore deemed it unnecessary to occupy themselves further with this impurity. They have nevertheless determined the amount of iron in several of their specimens of zinc. That from New Jersey contained 0·2088 per cent of iron.

In regard to nickel, cobalt, manganese, etc., which have been said to occur at times in zinc, the authors remark that, "the occurrence of these metals has been denied just as often as it has been asserted, but it is of course impossible to assert the universal negative, that these metals are never to be found in any spelter. * * * * Thus much may be safely asserted, however, that if nickel, cobalt, and manganese are ever to be found in commercial zinc, they occur there accidentally, exceptionally, abnormally, and in quantities hardly to be appreciated, and utterly insignificant."

"*Carbon.*—With reference to carbon as an impurity of zinc, we have attempted to determine this single point,—Does it occur in the residue insoluble in dilute acids, as has been generally believed, but never to our knowledge proved? One fact alone renders the occurrence of carbon, or of any other non-metallic substance, in this residue extremely improbable. We have observed that the residues from the Silesian, New Jersey, Rousseau Frères, Berlin, and Mint zincs are completely dissolved in perchlorid of iron, acidulated with chlorhydric acid. If carbon or silica were present in any appreciable quantity, complete solution of the residue in this reagent could not be expected. In testing the residues from our various spelters for carbon, we adopted the following process.

"From thirty to forty grammes of the zinc to be tested were dissolved in pure dilute chlorhydric acid, the black residue thoroughly washed with hot water, and, dried at a heat much below one hundred degrees (C.). The dry, grayish powder was then ground up with fused chromate of lead, and the mixture was introduced into a small bulb, blown in a tube whose diameter was not quite a centimetre. At a short distance from the bulb, this tube was drawn down to a diameter of one or two millimetres, and the extremity of the fine tube placed under lime-water in a small test-glass. The bulb was heated till the chromate of lead was fused, and if any carbon had been present in the residue, the evolved gas would have caused a cloudiness or precipitation of carbonate of lime in the lime-water. In this manner we first tested our chromate of lead by itself, and found no cloud or precipitate in the lime-water. We next inserted the smallest possible particle of carbon into the bulb with a little chromate of lead, and obtained a large distinct cloud of carbonate of lime in the lime-water in the test-glass, and in the capillary tube which delivered the gas. Having thus proved the purity of the reagent employed, and the extreme delicacy of the test, we tested in succession the residues from Silesian, Vieille Montagne, and Ber-

* Specially by Karsten in Karsten u. Dechen's *Archiv f. Mineralogie*, xvi, 623; also Dingler's *Polyt. Journ.*, lxxxvi, 193.

lin zincs, and from the zinc of Rousseau Frères. As precisely the same result was obtained with each of these zincs, it may be stated once for all.

"On heating the mixture of residue and chromate of lead till the chromate fused there appeared in each case a very slight deposit on the upper surface of the lime-water column in the fine tube. This deposit could not have been smaller and yet been visible; it was incomparably less than that produced by the atom of carbon which was purposely introduced into a similar tube, and was undoubtedly caused by the slight dust which collected on the residues during the processes of washing and drying, and which no possible precautions could entirely avoid. It is obvious from these experiments, that the often repeated statement, that the insoluble residue from zinc treated with dilute acids is carbon, rests on no adequate foundations, and that carbon is not an invariable constituent of crude zinc, as it is of iron. But on the other hand it is impossible to assert that carbon does not sometimes occur in commercial zinc as an accidental and wholly abnormal impurity. Thus in the specimen of New Jersey zinc which we examined, there were certain small cavities lined with black, as if a bubble of some carbonaceous gas had been decomposed within them, and the residue from this zinc, when tested as above described for carbon, produced a distinct cloudiness in the lime-water, which was sufficient evidence of the presence of a trace of carbon in this spelter; but the amount of this impurity was infinitesimal, and not at all to be compared in quantity with the lead and other metallic admixtures of which the residue mainly consisted. The presence of a little copper in this zinc may perhaps be connected with the occurrence of this trace of carbon. The residues from three of the English spelters also gave distinct reactions for carbonic acid in the lime-water; but, judging from the exceedingly small cloud of carbonate of lime produced, the amount of carbon in these zincs is even less considerable than that detected in the New Jersey zinc. The other English zinc (that from the works of Messrs. Vivian) yielded but the merest trace of carbonate of lime,—a little larger deposit, perhaps, than that obtained from the Silesian, Vieille Montagne, and other zincs first experimented upon, but not more than may easily have been derived from the invisible dust which undoubtedly collected on the residue. From none of these zincs could we obtain nearly as much carbonate of lime in the test-glass as we got from the smallest possible atom of carbon heated with chromate of lead; and it is quite clear that there is never anything more than an infinitesimal amount of carbon in the considerable residue which remains when thirty or forty grammes of commercial zinc are dissolved in dilute acids.

"Against the common opinion that carbon is one of the principal impurities of zinc, we would refer to the previously quoted statement of Wackenroder, who considered carbon only an accidental and mechanical impurity, and to the exact experiments of Karsten, who endeavored to determine the carbon in Silesian zinc by decomposing chlorid of silver and chlorid of copper by zinc, but 'could find no trace of carbon in either the hard or the soft kinds of zinc.'*

"*Sulphur.*—It has been frequently stated that sulphur is a common impurity of zinc, and that it even occurs in the insoluble residue in combination with lead. We first tested the insoluble residue from Silesian zinc for sulphur, by dissolving about 30 grammes of the zinc in pure chlorhydric acid, separating the black residue, and dissolving it in pure nitric acid. It dissolved without any appreciable residue (another evidence of the non-existence of tin in this spelter), and the diluted solution gave no precipitate whatever with nitrate of baryta. With 40 grammes of Vieille Montagne zinc, we obtained precisely the same result. The Pennsylvanian zinc leaves no residue when treated with dilute acids, and is therefore free from lead, and certainly contains no carbon or sulphur which manifest themselves as an insoluble residue. The New Jersey zinc gave an exceptional result. The blackish residue, from 32 grammes of this zinc, could not be completely dissolved in boiling nitric acid. The partial solution gave no precipitate with nitrate of baryta; the undissolved portion was fused before the blowpipe with carbonate of soda free from sulphur, and gave a distinct reaction, first for sulphur, and secondly for tin. The presence of tin in this spelter has already been demonstrated, and a minute trace of sulphur must also be counted among its impurities.

* Archiv f. Mineralogie, Karsten u. Dechen, 1842, xvi, 607. Karsten also says: "I have cemented sheet zinc with coal for many days, and then melted it; but in the resulting mass of zinc I have found no trace of carbon." Ibid., 608.

"In addition to this negative evidence, that no precipitation is produced by barium salts in the diluted nitric acid solution of the residues from the various zincs, we would adduce positive experiments to show that any compound of sulphur with a metal, which might be present in the zinc, would, in all probability, be decomposed in presence of an excess of zinc and free acid.

"Wackenroder,* in the memoir already cited, distinctly states that the black residue from zinc is sulphid of lead,—a statement at first sight sufficiently plausible, but really inconsistent with the facts of the case. When precipitated sulphid of lead is mixed with a large excess of granulated zinc (Silesian, Vieille Montagne, or Pennsylvanian), and treated with moderately dilute sulphuric or chlorhydric acid, the black sulphid soon entirely disappears, while torrents of sulphuretted hydrogen are evolved. If, after all the zinc has been completely dissolved, the insoluble residue is fused before the blowpipe with carbonate of soda free from sulphuric acid, the mass thus obtained will not blacken silver.

"If powdered galena be substituted for precipitated sulphid of lead, the same effects will be produced, though much more slowly. The sulphid of lead, therefore, suffers complete decomposition in presence of an excess of zinc and free acid, and it is of course absolutely impossible that this substance should be found in the insoluble residue.†

"The presence of sulphur in the insoluble residue from zinc is, without doubt, very rare; but it is also an unquestionable fact, that a certain amount of sulphuretted hydrogen gas is generated whenever commercial zinc is treated with dilute acids. This phenomenon has been often observed. Thus Blancard‡ remarks, 'that the sulphur often contained in commercial zinc may be shown by bringing paper wet with acetate of lead in contact with the gas developed therefrom.' Fordos and Gélis§ say, that 'the formation of this gas (sulphuretted hydrogen) can only be attributed to the partial reduction of the sulphuric acid by the nascent hydrogen.' Subsequently Jacquelain,‖ doubting this supposed reduction of sulphuric acid, attributes the production of sulphuretted hydrogen to the presence of sulphurous acid or other compounds of sulphur, with which the sulphuric acid is contaminated. Every specimen of zinc in our possession develops sulphuretted hydrogen when treated with dilute sulphuric or chlorhydric acid, as may be manifested by placing a slip of paper moistened with alkaline acetate of lead in the neck of the flask which contains the zinc and acid. But the question recurs, What is the source of the sulphur which is necessary for the generation of this gas? Is it contained in the zinc, or is it derived from the acids used in the experiment? To obtain a satisfactory solution of this problem, it is necessary to use an acid which does not contain sulphur in any form. Sulphuric acid will not answer the purposes we have in view in this experiment; for though it is undoubtedly possible to prepare sulphuric acid free from sulphurous acid, yet the doubt would still remain concerning the reduction of the sulphuric acid by the hydrogen,—a reduction not impossible at certain temperatures and in certain states of concentration. In testing for a minute trace of sulphur in zinc, it is evidently undesirable to employ a reagent which contains sulphur, in however stable a combination. Sulphuric acid being then excluded, will chlorhydric acid answer the purpose? It is easy to prepare chlorhydric acid which gives no precipitate with baryta salts, but it is very difficult to prepare this acid from common salt and sulphuric acid, so that, while containing no chlorine, it shall be absolutely free from sulphurous acid, or some lower compounds of sul-

* *Ann. der Pharm.*, 1834, x, 53.

† We have observed that the sulphids of tin and copper are also decomposed when mixed with an excess of zinc and dilute acid. The sulphid of copper was rapidly decomposed, and the residue, after all the zinc had been dissolved, yielded only a very uncertain trace of sulphur before the blowpipe. Precipitated bisulphid of tin was decomposed much less readily, and when all the zinc had disappeared, the residue gave indications of sulphur before the blowpipe. Although this might have arisen from some impurity in the tinfoil from which the sulphid was prepared, yet it was evident that the decomposition of the sulphid of tin is effected with much greater difficulty than that of the sulphids of lead and copper.

‡ Jour. de Pharmacie, 1841, p. 543, in Dingler's Polyt. Jour. 1841, lxxxii, 425.

§ Comptes Rendus, 1841, xiii, 437.

‖ Ann. de Ch. et Phys., 1843, [3,] vii, 189.

phur. Loewenthal's* test with sesquichlorid of iron and ferricyanid of potassium will reveal the presence of such compounds of sulphur in chlorhydric acid made with the utmost care, and in other respects pure. By means of chlorine or some similar oxydizing agent, these compounds of sulphur may undoubtedly be oxydized, or at least the larger part of these admixtures may be converted into sulphuric acid; whether their last traces can be oxydized in this way is a point by no means beyond a doubt. But if the chlorhydric acid has been treated with chlorine to accomplish this oxydation, it becomes necessary to remove from the acid the excess of the oxydizing agent, for sulphuretted hydrogen would not be developed from zinc, contaminated with sulphur, by an acid which contained free chlorine, or any substance of like properties. Thus common chlorhydric acid very often contains free chlorine, and no zinc will yield with such acid anything more than a very uncertain reaction for sulphur on lead-paper. To obtain chlorhydric acid which was above suspicion, and unquestionably free from every trace of sulphur, and from every oxydizing agent which might interfere with our reaction for sulphur in zinc, we found so difficult a task, that we finally rejected this acid altogether, and resorted to the following process. A solution of chlorid of calcium, free from every trace of sulphur, was first prepared by dissolving carbonate of lime in chlorhydric acid, adding ammonia in excess to the boiling solution, filtering off the precipitated oxyds of iron and alumina, adding to the filtrate chlorid of barium, and evaporating to dryness. The residue was dissolved in distilled water, and in this solution a slight excess of chlorid of barium was present, as was proved by the precipitate produced by a solution of sulphate of lime. Oxalic acid free from sulphur was then prepared by the following process: a quantity of commercial oxalic acid was treated with enough cold water to dissolve about half of the acid taken, and the cold solution thus obtained was partially evaporated and crystallized; the mass of crystals was washed with a saturated solution of a portion of the crystals, and was finally dissolved in distilled water. In these two reagents, the chlorid of calcium and the oxalic acid, so prepared, no sulphur could be detected, either by barium salts, Loewenthal's test, or by the blowpipe reaction on silver.

"We applied to every zinc in our possession the following test for sulphur. 10 or 15 grammes of zinc were introduced into a small flask, and a portion of the solution of chlorid of calcium and of oxalic acid added thereto; hydrogen gas was freely developed, and was tested for any sulphuretted hydrogen which it might contain, by placing a slip of paper moistened with alkaline acetate of lead in the narrow neck of the flask. In every case the paper was immediately and strongly blackened, showing conclusively that every one of the following zincs contains sulphur in a quantity extremely minute, but distinctly appreciable if a sufficiently delicate test be applied:—

1. Vieille Montagne zinc (in two distinct samples).
2. Silesian zinc.
3. The United States Mint zinc.
4. Pennsylvanian zinc.
5. Rousseau Frères zinc.
6. Berlin sheet zinc.
7. Silesian zinc (subjected to Meillet's† process for purification from arsenic).
8. New Jersey zinc.
9. " " (reduced by us from the New Jersey white zinc oxyd).
10. English zinc (in four distinct samples).

"These results are not in accordance with the statements of some previous observers. Thus Karsten, in the memoir previously cited, infers that sulphur is not contained in Silesian zinc, from the fact that he obtained no precipitate in passing the gas generated by this zinc through a solution of acetate of lead. But it must be remembered, first, that we have no evidence that Karsten's acids were free from oxydizing agents, and secondly, that the reaction for sulphur on lead-paper is a more delicate test than any process of causing the gas generated to bubble through a liquid, even though the best form of apparatus be employed to secure as far as possible thorough contact of the gas with the fluid. Moreover, Karsten subsequently men-

* Jour. pr. Chem., lx, 267.
† Dingler's Polyt. Jour., 1842, lxxxiii, 205, from Jour. de Pharmacie, 1841, 625.

tions that a delicate black precipitate is produced when the hydrogen from zinc is passed through nitrate of silver; this precipitate was probably sulphid of silver, and not metallic silver, as Karsten conjectured.

"Again, Jacquelain, in the memoir already referred to, concludes that sulphur was not contained in the specimen of French zinc which he examined, because a complete solution of the zinc in aqua regia gives no precipitate with chlorid of barium. But obviously the precipitation of sulphate of baryta in aqua regia is by no means a sufficiently delicate test for an amount of sulphur at best exceedingly minute. In the same paper, Jacquelain, criticising the observation reported by Fordos and Gélis of the generation of sulphuretted hydrogen from zinc and dilute sulphuric acid, implies that there is no sulphur in zinc by stating that the development of sulphuretted hydrogen from zinc may be avoided by using properly prepared acid. The acid which Jacquelain used had been saturated with chlorine gas, in a process of which the principal object was the purification of the sulphuric acid from sulphurous acid. That this acid occasioned no development of sulphuretted hydrogen from the zinc is not to be wondered at, but it is not to be argued from this fact, that there is no sulphur in zinc. With regard to sulphur in the zinc from New Jersey, Alger* has remarked that the New Jersey zinc ore is known to contain no sulphur; but, on the other hand, Jackson† observed the sulphuret of zinc in the mine of red oxyd of zinc in Franklin, Sussex County, New Jersey, and a simple experiment demonstrated to us the existence of sulphur in that ore. 10 or 15 grammes of the red oxyd of zinc, not entirely free from the gangue of carbonate of lime in which the ore occurs, were reduced to a fine powder, and treated with moderately dilute pure sulphuric acid. A vigorous evolution of sulphuretted hydrogen was the immediate result."

As a general result it appears therefore that in all commercial zincs metallic lead is the principal impurity: while it is gratifying to observe that the purest of all the zincs which have been analyzed by Messrs. Eliot and Storer is that manufactured at the Pennsylvania and Lehigh Zinc Works, at Bethlehem, Pennsylvania. This spelter leaves no appreciable residue when dissolved in dilute acids, and therefore contains no lead; indeed a trace of cadmium is the only impurity whose presence in the zinc the authors can confidently assert. The ore from which this spelter is made is the hydrated silicate of zinc (electric calamine), and it is not surprising that this mineral should yield zinc of singular purity, if the ore be carefully selected.

We have here purposely omitted any allusion to the valuable discussion upon the occurrence of arsenic in zinc into which the authors have been drawn, since we propose to cite their remarks upon this subject in full in a subsequent number.

2. *A Practical Treatise on Coal, Petroleum, and other distilled Oils;* by ABRAHAM GESNER, M.D., F.G.S. New York. Baillière Brothers, 1860, 8vo, pp. 134.—This book is just what it claims to be in its title, A *Practical Treatise* on the comparatively new art of producing oils for illumination and machinery from coal and its congeners. As a contribution to the recorded technology of an obscure subject it is a decided step in advance. It describes in as simple and direct terms as the inherent complexity of the subject permits, the method of preparing and purifying coal oils and the natural oils (rock oils) allied to them. The scientific chemist as well as the technical manufacturer will find these descriptions plain matter-of-fact statements, of a man thoroughly versed in the practical details and administration of his art, and much of it of a positive and valuable addition to what was previously accessible in books.

* Am J. Sci., xlviii, 253. † Proc. Am. Association, 1850, iv, 336.

The author recognizes the intimate relation of the manufacture of coal oils with the production in such increasing abundance of petroleum, destined to become a powerful competitor of the artificial product, for economic use. He states the number of oil wells in Western Pennsylvania and Ohio as not less than five hundred and fifty, opened or in process of boring, and yielding by estimate not less than 25,000 to 30,000 gallons daily. It is instructive in this connection to recall the fact that the natural product (petroleum) which has been well known from the earliest records of human history, should have remained comparatively useless and almost neglected until the modern art of coal oil distillation, has shown its industrial value. It is quite possible that the future historian of the industrial arts may look back on the coal oil distillation as only an episode in the history of the development of the use of petroleum.

We would not be understood however as giving to Dr. G.'s book an unqualified approval. It abounds in loose, careless statements likely to confuse and mislead his readers; such is his allusion to "Electricity" on p. 17, which he says "plays an important part in the changes which occur during distillation." It is time this force ceased to be the *pons asinorum* whenever in matters of science ignorance lacks the courage to avow its weakness. When (as on p. 59) the author says, "A number of compounds of carbon and hydrogen have been confounded with paraffine—such as methylene, ethylene, butylene," &c., he darkens council by words without knowledge. Since no one is likely to mistake these three *gaseous* products, C_2H_2, C_4H_4 and C_8H_8, the second of which, ethylene, is '*olefiant gas*' and the third is '*oil gas*,' for the beautiful white crystalline paraffine, whose formula may be as our author states, on the authority of Lewis, $C_{20}H_{21}$, or it may be $C_{48}H_{50}$. What he meant to say doubtless was that many substances termed paraffine consist of a mixture of several polymeric hydrocarbons, which form the higher terms of a series to which olefiant gas belongs—which is probably the fact.

Chemists will be curious to know the evidence on which Dr. G. rests the "Homologous series obtained from the bitumen of Trinidad," (page 86) embracing by enumeration nineteen consecutive compounds on the assumed type $C_{n+1}H_n$. Such vague assertions will neither, as he supposes, "interest the professional chemist," or extend the bounds of science. Like too many technical works printed in this country, this book abounds in typographical errors—such as the persistent use of analine for aniline.

Considering the author's well-known position as plaintiff in the case of Gesner vs. Cairnes—we esteem his allusion to the "Albert Coal" to be in bad taste, since it gives only a partizan view of a case where the testimony was very various and evenly balanced, as the printed minutes of the case from the notes of the Judge clearly show.* There are many other things in this book open to criticism which we hope will be corrected in a second edition.

3. *General Problems from the Orthographic Projections of Descriptive Geometry; with their Applications to Oblique—including Isometrical—Projections, Graphical Constructions in Spherical Trigonometry, Topographical Projection, and Graphical Transformations;* by S. EDWARD

* Report of a case tried at Albert Circuit, 1852, before his Honor Judge Wilmot and a special Jury. Abraham Gesner vs. William Cairnes, copied from the Judge's Notes. St. John, N. B., 1853. 8vo, pp. 167.

Warren, C.E., Professor of Descriptive Geometry and Geometrical Drawing in the Rensselaer Polytechnic Institute, Troy, N. Y., 412 pp., 8vo. New York: John Wiley, 1860.—This is a more extended work than any other American treatise on Descriptive Geometry which has hitherto appeared. It is rigorously systematic and truly philosophical in its general plan, but is open to the objection of being encumbered with a complex system of divisions, and subdivisions in a descending scale, that will not be apprehended readily by the student. Notwithstanding this objection, the work is on the whole admirably adapted to secure the important educational benefits to be derived from such a study —the realization of a true mental culture, as well as the acquisition of exact knowledge. From this point of view the most striking feature is the plan of prefixing to the detailed solution of each problem, an outline sketch of the process, given without reference to a diagram, which the author terms a "Solution in Space." Another commendable feature is the thoroughness, and fullness of detail with which the more important elementary problems are worked up.

The problems relating to each of the four general classes of surfaces are arranged under four distinct heads, or "Classes of Operations;" viz: Projections, Intersections, Tangencies, and Developments. In his mode of treatment of some of these topics the author has displayed considerable originality. The doctrine of tangency especially is presented in a new light. A new definition is given of a tangent line not liable to certain plausible objections that may be urged against the definition generally adopted, and which may be more readily and more distinctly apprehended by the student, and conducts more readily to the rules for drawing tangents to special curves. But if the author desires that the definition he has given shall maintain its ground, the task devolves upon him of showing that it is completely reconcilable with the principles of geometrical analysis, and would accommodate itself to analytical as well as purely geometrical investigations.

We hail with pleasure the appearance of so comprehensive and thorough a treatise upon a branch of mathematics which holds so prominent a place in our schools of practical science, and commend it to the attention of all who are desirous of obtaining a complete knowledge of the mathematical theory of geometrical drawing.

4. *Cooke's Chemical Physics.*—A critical and complimentary notice of Prof. Cooke's elaborate and excellent work, in the London Athenæum for Nov. 17, concludes with these words:

"As an introduction to chemical physics, this is by far the most comprehensive work in our language. We only fear that it may be considered too extended for use in the class-room. We have, however, no doubt that it will find its way into the library of students who are ambitious of laying a secure foundation for their chemical knowledge."

5. Silliman: Principles of Physics—2d edition. Revised and rewritten. Small 8vo, pp. 700. Philadelphia, Peck & Bliss. 1861.—This new edition varies from the first chiefly in the addition of mathematical demonstrations, and problems for exercise, and in the recomposition of nearly the whole of the first two parts—while the whole is enriched by numerous additions, designed to make it an exact and useful manual for the teacher as well as for the student.

V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Earthquake.*—About 6 A. M., on the 17th of October, 1860, Canada and the northern United States were visited by an earthquake vibration of a more general and impressive character than any which has occurred for many years. The shock appears by the observations of Dr. Smallwood, and others, to have proceeded from the east to the west. Its point of greatest intensity was low down on the St. Lawrence. Near Rivière Ouelle and Rivière du Loup, proceeding thence with diminishing intensity as far west as Hamilton. It was generally felt throughout northern and eastern New England, and as far west as Auburn, in the State of New York. At Newark, New Jersey, it was very slight and this appears to be its extreme southerly reach. Dr. Dawson* has collected the following observations from about twenty places in Canada arranged in order of their longitudes from east to west. It will be observed that the time is earlier in eastern localities, but on comparing Bic and Belleville, nearly nine degrees apart, the difference of time will be seen to be but little less than that due to the difference of longitude. The Hamilton observation would give an earlier time, but as the shock was slight and the testimony of only one observer was recorded, there may be an error. The shock thus appears to have been nearly simultaneous throughout Canada.

Bic, 6 A. M. Three shocks at intervals of some seconds, noise continued for ten minutes.

Green Island, 6, A. M.

Rivière du Loup, 6 A. M. A series of shocks lasting nearly five minutes. A schooner off this place experienced a shock resembling that of striking on a sand-bank, and the waters of the Gulf were unusually agitated.

River Ouelle, 6.15 A. M. Very violent, damaging walls and throwing down chimneys, especially in low grounds.

Eboulements, near Murray Bay, 5.30 A. M. Violent. Five other feeble shocks in rapid succession, another at noon and another at 5 P. M. This is the only place where these latter shocks are mentioned, but the hour of the first is probably an error, as Bay St. Paul, quite near Eboulements, agrees in this respect more nearly with other places.

Bay St. Paul, 5.50 A. M. Violent shock; chimneys fell.

St. Thomas (Montmagny) 6 A. M. Two shocks.

St. Joseph de la Beauce, 6.10 A. M.

Quebec, 5.50 A. M. Several shocks, severe, especially in lower parts of the city and in the environs; but less so than at River Ouelle, &c.

Leeds, Megantic, 6.10 to 6.15 A. M.

Richmond, 5.45, A. M.

Three Rivers, about 6 A. M. Shocks felt for two minutes.

Granby, about 6 A. M.

St. Hyacinthe, 5.45 A. M. Three shocks continuing more than a minute, buildings reported damaged.

Maskinonge, 6 A. M. Shocks felt for more than a minute, supposed to be from north to south.

Montreal, 5.50. Two or three perceptible shocks, felt less on the mountain than on lower ground.

St. Martin, Isle Jesus, 5.55. At Dr. Smallwood's observatory, two distinct and smart shocks. The wave passed from east to west. Barometer 29·964 inches, temperature 40° 3, wind N. E., cloudy.

Cornwall, 6 A. M.

Prescott, 5.30 A. M.

Belleville, 5.30 A. M. One shock.

Hamilton, 4.45, A. M.

* Canadian Naturalist, Oct., 1860, 363.

"In all or nearly all of the above places the earthquake was preceded by a rumbling noise which gradually decreased after the vibrations had passed. The difference of duration ascribed to the shocks appears to arise mainly from the circumstance that some observers include the continuance of vibration in buildings, &c., as well as that of the subterranean sound; and in this way it is probable that by some persons two or more shocks have been regarded as one.

"The observation of Dr. Smallwood that the wave proceeded from east to west, may be regarded as correct. At the same time the nearly simultaneous occurrence of the shock throughout Canada, perhaps indicates that the wave did not move horizontally but reached the surface from a great depth and at a high angle as Perrey of Dijon seems to suppose the earthquakes of Eastern America have usually done. It must however be observed that at the rate of propagation given by Mallet for earthquake waves through hard rock, which is not less than 10,000 feet per second, it is quite possible that even a horizontal wave may appear to be felt at the same instant at great distances.

"All the observers agree that the sound preceded the shock and continued after it, and that the first shock was the most violent; and it is also very generally noted that it was most severely felt on low ground and least so on rocky eminences. This last character which belongs to earthquakes generally, seems to arise from the greater resistance opposed to the vibrations by loose materials as compared with hard rocks.

"It appears from the published lists that the late earthquake is the last of at least twenty-nine that have visited Canada since its discovery by Europeans."

3. *Two New Meteorites;* by J. Lawrence Smith, (in a letter to the Editors, dated, Louisville, Ky., Nov. 19th, 1860).—There have just come into my possession, two new meteoric irons; one weighing one hundred and twelve pounds from Oldham County, near LaGrange, Ky.; the other weighing thirty-seven pounds, from Robertson county, near Coopertown, Tenn. A description of them with analyses will be given in an early number of this Journal.

OBITUARY.

J. P. Espy.—The death of Mr. Espy was announced by us in vol. xxix, p. 304; the following notice of his life was communicated by Prof. A. D. Bache, at a recent meeting of the Board of Regents of the Smithsonian Institution, and forms part of the Report for 1859, p. 108.

"James P. Espy, one of the most original and successful meteorologists of the present time, died in Cincinnati, Ohio, on the 24th of January, 1860, in the seventy-fifth year of his age, after an illness of a week, at the residence of his nephew, John Westcott.

The early career of Mr. Espy as an instructor was marked by the qualities which led to his later distinction in science. He was one of the best classical and mathematical instructors in Philadelphia, which at that day numbered Dr. Wylie, Mr. Sanderson, and Mr. Crawford among its teachers.

Impressed by the researches and writings of Dalton and of Daniell on meteorology, Mr. Espy began to observe the phenomena, and then to experiment on the facts which form the groundwork of the science. As he observed, experimented, and studied, his enthusiasm grew, and his desire to devote himself exclusively to the increase and diffusion of the science finally became so strong that he determined to give up his school, and to rely for the means of prosecuting his researches upon his slender savings and the success of his lectures, probably the most original which have ever been

delivered on this subject. His first course was delivered before the Franklin Institute of Pennsylvania, of which he had long been an active member, and where he met kindred spirits, ready to discuss the principles or the applications of science, and prepared to extend their views over the whole horizon of physical and mechanical research. As chairman of the committee on meteorology, Mr. Espy had a large share in the organization of the complete system of meteorological observations carried on by the Institute under the auspices and within the limits of the State of Pennsylvania.

Mr. Espy's theory of storms was developed in successive memoirs in the Journal of the Franklin Institute, containing discussions of the changes of temperature, pressure, and moisture of the air, and in the direction and force of the wind and other phenomena attending remarkable storms in the United States and on the ocean adjacent to the Atlantic and Gulf Coast. Assuming great simplicity as it was developed, and founded on the established laws of physics and upon ingenious and well-directed original experiments, this theory drew general attention to itself, especially in the United States. A memoir submitted anonymously to the American Philosophical Society of Philadelphia gained for Mr. Espy the award of the Magellanic premium in the year 1836, after a discussion remarkable for ingenuity and closeness in its progress, and for the almost unanimity of its result.

Mr. Espy was eminently social in his mental habits, full of bonhommie and of enthusiasm, easily kindling into a glow by social mental action. In the meetings and free discussions in a club formed for promoting research, and especially for scrutinizing the labors of its members—and of which Sears C. Walker, Professor Henry, Henry D. Rogers, and myself were members—Mr. Espy found the mental stimulus that he needed, and the criticism which he courted, the best aids and checks on his observations, speculations, and experiments. But there was one person who had more influence upon him than all others besides, stimulating him to progress, and urging him forward in each step with a zeal which never flagged—this was his wife. Having no children to occupy her care, and being of high mental endowment and of enthusiastic temperament, she found a never-failing source of interest and gratification in watching the development of Mr. Espy's scientific ideas, the progress of his experiments, and the results of his reading and studies; the collection and collation of observations of natural phenomena in the poetical region of the storm, the tornado, and of the aurora. Mrs. Espy's mind was essentially literary and she could not aid her husband in his scientific inquiries or experimeuts: her health was delicate, and she could not assist him in his out-door observations; but she supplied what was of more importance than these aids—a genial and loving interest ever manifested in his pursuits and successes, and in his very failures. *Alere flammam* was the office of her delicate and poetical temperament. Younger than Mr. Espy, she nevertheless died several years before him, (in 1850,) leaving him to struggle alone in the decline of life without the sustaining power of her devoted and enthusiastic nature.

Having in a great degree matured his theory of storms; having made numerous inductions from observations, and having written a great deal in regard to it, Mr. Espy took the bold resolution, though past middle age, to throw himself into a new career, laying aside all ordinary employments, and devoting himself to the diffusion of the knowledge which he had collected and increased, by lecturing in the towns, villages, and cities of the United States. This proved a successful undertaking, and by its originality attracted more attention to his views than could have been obtained probably, in any other way. He soon showed remarkable power in explaining his ideas. His simplicity and clearness enabled his hearers to follow him without too great effort, and the earnestness with which he spoke out his convictions carried them away in favor of his theory. The same power which enabled him to succeed in his lecturing career procured subsequently for Mr. Espy the support and encouragement of some of the leading men in Congress, and especially in the Senate, and also in the executive departments. Their attention was arrested by the originality of his views and his warmth in presenting them, and he imparted so much of his conviction of their truth as to induce many of our statesmen and official persons to exert themselves to procure for him, under the patronage of the government, continued opportunities for study, research, and the comparison of observations. To the consistent support of his scientific friends, and particularly of the Secretary of this Institution, Mr. Espy owed also much in obtaining the opportunities of keeping in a scientific career. His reports to the Surgeon General of the army, to Congress, and to the Secretary of the Navy, are among his latest efforts in this direction.

The earnest and deep convictions of the truth of his theory in all its parts, and his glowing enthusiasm in regard to it; perhaps, also, the age which he had reached, prevented Mr. Espy from passing beyond a certain point in its development. The same constitution of mind rendered his inductions from observation often unsafe. His views were positive and his conclusions absolute, and so was the expression of them. He was not prone to examine and re-examine premises and conclusions, but considered what had once been passed upon by his judgment as finally settled. Hence his views did not make that impression upon cooler temperaments among men of science to which they were entitled—obtaining more credit among scholars and men of general reading in our country than among scientific men and making but little progress abroad.

Feeling that his bodily vigor was failing, and that his life must soon close, the Secretary of the Smithsonian Institution induced him to re-examine the various parts of his meteorological theories of storms, tornadoes and water spouts, and to insert in his last report, while it was going through the press, an account of his most mature views. I trust that the Secretary will, in one of his reports, give us a thorough and critical examination of the works and services of this remarkable contributor to a branch of science, the knowledge of which the Smithsonian Institution has already done so much to advance and to diffuse."

On motion of Professor Bache, the following resolutions were adopted:

Resolved, That the Regents of the Smithsonian Institution have learned with deep regret the decease of James P. Espy, one of the most useful and zealous of the meteorologists co-operating with the Institution, and whose labors in both the increase and diffusion of knowledge of meteorology have merited the highest honors of science at home and have added to the reputation of our country abroad.

Resolved, That the Regents offer to the relatives of Mr. Espy their sincere condolence in the loss which they have sustained.

On motion of Mr. Pearce, it was resolved that the remarks of Professor Bache be entered in the proceedings.

David Dale Owen, well-known as a geologist and chemist, died at his residence, New Harmony, Indiana, November 13th, 1860, aged 53. Dr. Owen has been long a contributor to this Journal and was widely known and highly esteemed as an assiduous explorer and author in the wide fields of American Geology. He was born June 24th, 1807, at Braxfield House, Lanarkshire, Scotland, where his father, Robert Owen, the eminent Philanthropist, was a large Mill owner. His mother was a daughter of David Dale, once Provost of Glasgow. Dr. Owen from 1823 to 1826, was educated at the well-known establishment of Emanuel Fellenberg, at Hofwyl, Switzerland, with three of his brothers; two of whom, (Hon. Robert Dale Owen, late American Minister Plenipotentiary at Naples, and Dr. Richard Owen,) yet survive. He subsequently spent a year in Glasgow, attending the chemical instructions of Dr. Andrew Ure. In 1828, Dr. Owen accompanied his father to the United States, where some time before, the latter had purchased a part of the town of New Harmony, Ia., as a site for testing his educational and philanthropic plans; arriving at New Orleans after an eight weeks' voyage, in January, 1829. Returning to Europe, in 1831–32,—after commencing his scientific labors in America—he visited Paris for the purpose of perfecting his hand in drawing from models, having a strong natural taste for the pencil, the evidence of which is visible in his numerous original drawings and sketches in his various geological Reports. In London, he resided for the next eighteen months, following the chemical lectures of Dr. Turner and visiting the

Museums and Geological Society. Returning to the United States, he was, in 1838, and subsequently, associated as a volunteer explorer with the late Dr. Troost, then engaged on the Geological Reconnoissance of Tennessee. He received his Medical diploma from the Ohio Medical College, in 1835, after two years' assiduous devotion to medical studies in Cincinnati. In 1837, he married Miss Caroline Neef, daughter of Joseph F. N. Neef, the former associate of Pestalozzi, in Switzerland, and later with Mr. William Maclure, in New Harmony.

Dr. Owen's responsible labors, as an explorer, commenced in 1837, when he took charge of the Geological Reconnoissance of Indiana, performing that labor chiefly on horseback in a comparatively new country. His report on the geology of Indiana, quite a small volume, was last year reprinted, by order of the Legislature of that State.

His appointment by the General Government, in 1839, to examine the mineral lands of Iowa, which it proposed to reserve from sale, resulted in a remarkable *tour de force*, by which he was able in an incredibly short space of time, with the aid of one hundred and ten persons, mostly selected among his fellow-townsmen, to examine each quarter section, (forty acres,) of a territory, 11,000 square miles in extent, and report upon it by the appointed time.* In 1848–50 he again, under the appointment of the General Government, surveyed Iowa; the Commission including also Wisconsin and Minnesota. The results of this Survey appeared in a quarto volume, in 1852, under the sanction of Congress.† This elaborate Report was illustrated by plates of fossils, some of which were 'medal-ruled' on steel, a process never before applied to the delineation of organic remains.

His Report on the Chippewa Land District of Wisconsin, was published under instructions from the United States Treasury Department, in 1849–50.‡ Soon after the completion of his second Iowa Report, he undertook the direction of the Kentucky Geological Survey, the manuscript for the fourth Report of which was sent to press only a few weeks before his death. The three elaborate volumes, already published, on the Kentucky Survey, have been previously noticed by us.§

In 1857, he undertook also the direction of the Geological Survey of Arkansas; the work in Kentucky, being so far completed, as to authorize his assuming new duties. The first volume, (8vo,) of the Arkansas Report, appeared in 1858, and the materials for a second volume, were in the printers' hands, at the time of his death; indeed he continued dictating daily, portions of this Report to within three days of his decease. He had, in 1859, accepted the offer made him by the Board of Agriculture, for the State of Indiana to direct the new Geological Survey of that State, with the understanding that the work should be performed by his brother, Dr. R. Owen, until the completion of the Arkansas Survey permitted his personal attention to that of Indiana. This work, we understand, remains in Dr. R. Owen's hands. Besides these great and responsible labors, Dr. Owen made numerous Geological examinations for individuals and Corporations. It is a great satisfaction to know that Science

* This Journal, [2,] xi, 294.
† See this Journal, [2,] xv, 296, xvi, 91.
‡ This Journal, [2,] ix, 1850.
§ This Journal, xxii, 272, xxv, 283, 447, xxix, 287.

will have the benefit of all Dr. Owen's public labors. The second report on the Geological Survey of Arkansas is in the hands of the printer, as also the fourth volume of the Kentucky report.

He has also left a monument of his industry and success in a fine museum and laboratory, at New Harmony, completed during the last year.

The disease of which Dr. Owen died, if not induced, was greatly aggravated by the long and severe exposures and privations to which his almost constant field labors exposed him.

He sleeps in the vault, (which was also that of his own family), of WILLIAM MACLURE, the father of American Geology, already consecrated to science as the last resting place of the eminent naturalist, THOMAS SAY.

Few men have labored more harmoniously with their associates, than Dr. Owen; whose catalogue of collaborators includes, Norwood, Shumard, Meek, Swallow, Lesquereux, Peter, Litton, Elderhorst and Joseph Lesley, Jr. His Reports bear testimony to the eminent sense of justice which led him to assign to each of his associates the share both of honor and responsibility which was his due. Nor should we fail to state that his eldest son, for the last year or two, has been his professional associate and assistant. In view of his great executive and scientific ability, rich experience, and comparative age, science had much to hope for in the continued life of Dr. Owen, and his loss is great in proportion to these reasonable hopes. It will be seen from an advertisement in this Number, that the administrator of Dr. Owen's estate, offers a part of his Scientific property for public sale.

MR. S. A. CASSEDAY died the latter part of September, of "congestive chill." His papers in connection with Mr. Lyon on Crinoidea, published in this Journal, were valuable contributions to American palæontology, to which he had devoted a large share of attention. He was a native and resident of Louisville, Ky.

Bibliography; by J. NICKLÈS.

PARIS, chez MALLET-BACHELIER.

Recherches sur l'équivalent mécanique de la chaleur, par G. A. HIRN. 1 vol. in 8° d. 340 pages, avec planches.—Cet ouvrage a été couronné, par la Société de Physique de Berlin, qui avait mise au concours la question si important, de l'équivalent mécanique de la chaleur.

PARIS, chez HACHETTE, rue Pierre-Sarrazin.

Cours de Droit Naturel, par JOUFFROY. 2 vol. in 12° d. 430 pages; ouvrage essentiellement philosophique et d'une très grande portée.

En Amérique et in Europe, par MARMIER. 1 vol. 12° d. 480 pages.—Cet ouvrage qui sera sourtout lu avec intérêt par les habitans des anciennes colonies françaises, telles que le Canada, la Louisiane, etc., est la réimpression d'une série d'articles qui out paru dans la Revue des deux Mondes. L'auteur est un voyageur fantaisiste, dont les productions littéraires sont fort en vogue en France.

La Norvège, par LOUIS ENAULT. 1 vol. in 12° d. 450 pages.—C'est un ouvrage du méme genre que le précédent et non moins estimé.

L'année scientifique et industrielle, par L. FIGUIER. 1 vol. in 12° d. 300 pages, 4me annéé.—Ouvrage essentiellement populaire et exposant d'une manière succincte, les principales découvertes accomplies dans l'année dans le domaine des sciences d'observation.

L'année musicale, par SCUDO.—A l'ouvrage de M. FIGUEIR vaut s'annexer l'année musicale, et—

L'année littéraire et dramatique, de M. VAPPEREAU.

PROCEEDINGS BOSTON SOC. NAT. HIST., continued from vol. xxx, 1860, MARCH—p. 241, (also 251.) On consecutive faunæ and their corresponding number of geological formations, as furnishing arguments against the theory of Darwin; *Prof. Agassiz.*—p. 242, Discussion on same by *Prof. Rogers;* and p. 244, rejoinder; *Agassiz.*—p. 245, On the colors of the Nacre of fresh water bivalves; *J. Lewis.*—p. 246, Views of the stratigraphical relations of deposits formed in an ocean under each of the three conditions of a *stationary*, a *subsiding*, and a *rising* position of the sea bottom; *W. B. Rogers.*—p. 249, Occurrence of so-called native Iron in Africa, (vol. v, p. 250, and vol. vi, p. 279, B. S. Proceed.) denied; *A. A. Hayes.*—p. 252, Description of new Ophiuridæ, belonging to the Smithsonian Institution and to the Museum of Comparative Zoology; *Theodore Lyman.*—p. 262, Genus *Pygorhynchus* (genus known before only fossil,) found living at Acapulco; *Agassiz.*—APRIL.—p. 271, On the distinctness of faunæ in time and space; *Prof. Agassiz.*—p. 273, Remarks, (supplementary,) on the movements of the ocean-floor; *W. B. Rogers.*—p. 274-5, discussed by *Agassiz, Rogers* and *Gould.*—p. 276, Exhibition of the albino children and a sketch of albinism, by *Dr. Kneland.*—Habits and distribution of the Gorilla and other anthropoid apes from personal observation on the West Coast of Africa; *M. Du Chaillu.*—p. 277, Table comprising the age, weight and height of 100 men from a Military Company in Boston; *Dr. B. J. Jeffries.*—MAY.—On two migratory parasites; *Prof. J. Wyman.*—p. 283, On some sub-Peat Deposits of Diatomaceæ; *A. M. Edwards*, New York.—p. 287, On the American White Ant, (*Termes frontalis, Hald.*); *S. H. Scudder.*—p. 290, On the "cocoanut pearl;" a rare calcareous concretion found in the interior of the Cocoa-nut; *Dr. J. Bacon.*—p. 293, Dissection of the poison apparatus of the Rattle Snake; *Dr. J. Wyman.*—p. 294, On the Albert Coal; *Prof. W. B. Rogers.*—p. 296, Descriptions of five new species of mammals discovered in West equatorial Africa; *P. B. Du Chaillu.*—p. 305, Analysis of juice of the leaf-stalks of common Rhubarb, [*R. rhaponticum*]; *C. T. Jackson.*—p. 305, List of the Birds of Cuba, compiled from two lists presented by D. J. Gundlach of Havana; *Dr. T. M. Brewer.*—p. 308, Notes upon the mode and plan of nidification of some of the Birds of Chili; *M. F. Germain*, of Santiago, presented by *Dr. Brewer.*—p. 306, On the foot-marks of the Connecticut River Sandstones; *Roswell Field.*—p. 317, Report on the Registering Thermometer of Dr. James Lewis; *Prof. W. B. Rogers.*—p. 319, Observations on the Geology and Palæontology of Burlington, Iowa; *C. A. White.*—Remarks on the last by Prof. *W. B. Rogers.*—p. 322, Observations by Mr. L. W. Bailey, in relation to an interesting locality of Diatomaceæ, at Oaklands, North Providence; *Prof. W. B. Rogers.*—p. 323, Descriptions of new shells collected by the United States North Pacific Exploring Expedition; *Dr. A. A. Gould.*—SEPTEMBER.—p. 345, "Report on supplying the city of Charlestown, Mass., with pure water," and on the phenomena connected with the tides at Mystic Pond; *Dr. A. A. Hayes.*—Synonymy of the species of Cyrenella, a genus of Mollusca belonging to the family of the Lucinidæ; *Temple Prime.*—p. 348, On a very fusible white mineral from Lake Superior, containing boracic acid; *Dr. A. A. Hayes.*—p. 349, Account of a recent visit to the coast of Labrador; *Dr. Henry Bryant.*—Account of a visit to some old mines in the vicinity of Franconia, N. H.; *Dr. C. T. Jackson.*—p. 350, On the fungous growth commonly called California beer seed; *Dr. White.*—Fossil skull of the Capybara; *The President.*—OCTOBER.—p. 353, On the conglomerate of Vermont; *Prof. Edward Hitchcock.*—p. 355, Letter in reference to a Canada lynx (*Lynx Canadensis*), killed in Carlisle, Mass., Sept. 9, 1860; *H. D. Thoreau.*—p. 356, Account of a recent visit to Lake Winnipeg and the Saskatchawan River; *S. H. Scudder.*—On the age of some of the sandstones of North America, generally considered as the Old Red Sandstone; *Prof. Agassiz.*—p. 357, On the black slate of Braintree, Mass., containing *Paradoxides*, and on similar strata in Newfoundland, near Lake Champlain, and in the vicinity of Quebec; *J. Marcou* (for a full report see p. 369).—NOVEMBER.—p. 358, Descriptions of ten mammals from equatorial Africa, collected by himself, and believed to be undescribed (continued); *Mr. DuChaillu.*—p. 367, Notice of a visit to Green Island, off the mouth of Chester Bay, Nova Scotia, by the Rev. I. Ambrose, M.A., Halifax; *Dr. Bryant.*—p. 382, Descriptions of new shells collected by the North Pacific Exploring Expedition (continued); *Dr. A. A. Gould.*

For list of books received, see March Number.